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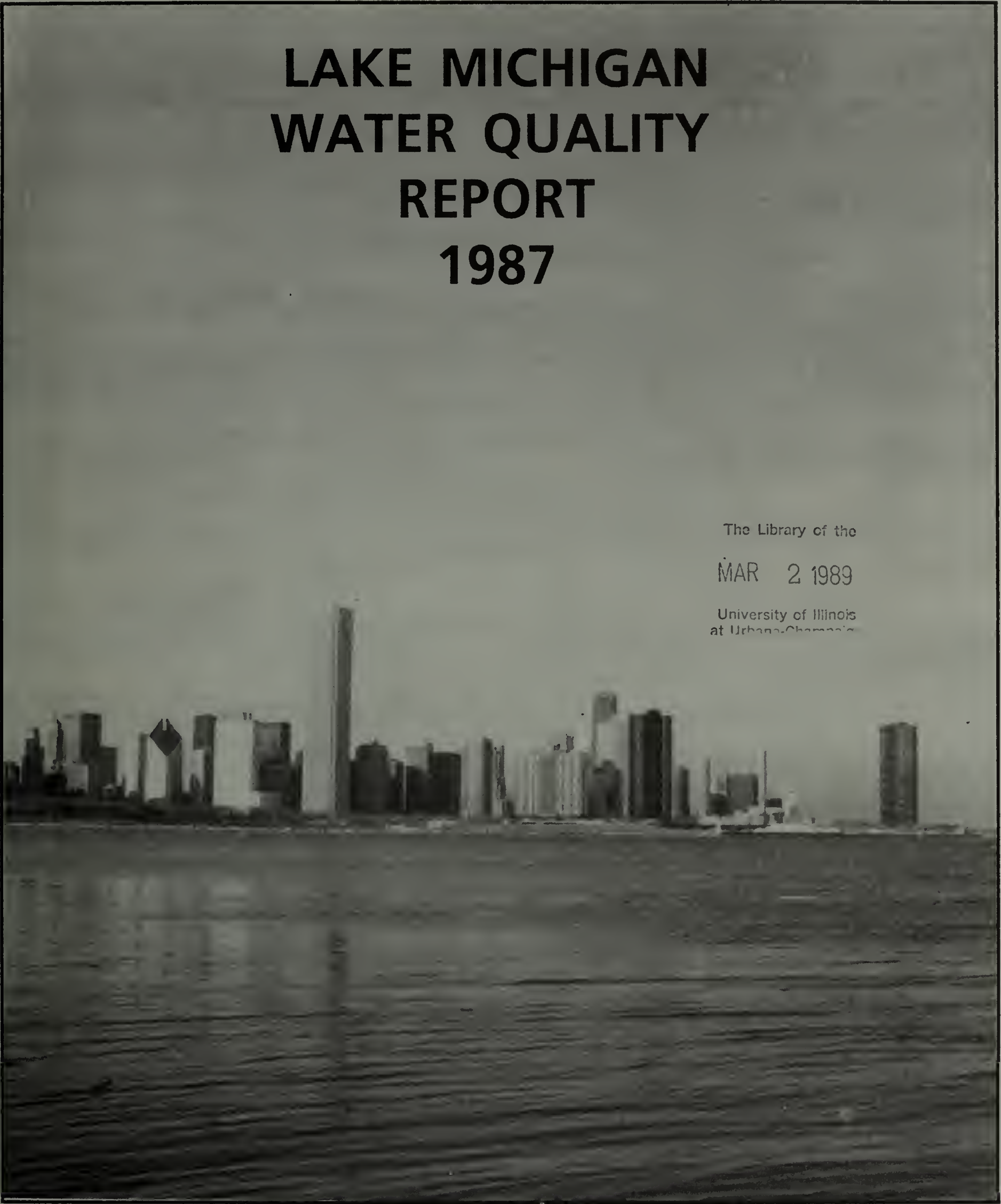

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APR 18 1989

LAKE MICHIGAN
WATER QUALITY REPORT
JANUARY THROUGH DECEMBER, 1987

by

THE CITY OF CHICAGO
DEPARTMENT OF WATER
BUREAU OF WATER OPERATIONS
DIVISION OF WATER PURIFICATION
WATER QUALITY SURVEILLANCE SECTION

and

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF WATER POLLUTION CONTROL
MONITORING UNIT

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY, 1987

Evaluation of the water quality of the southwest portion of Lake Michigan is based on standards as set by the Illinois Pollution Control Board (35 IL Adm Code 302). Because it is a unique and invaluable resource, Lake Michigan is protected to a higher level than other lakes in the State. Its waters are required to meet: Lake Michigan Standards, General Use Standards and Public and Food Processing Water Supply Standards. Additionally, a criterion for beach closure was also used in this evaluation (IDPH, 1987).

The water quality of the Illinois area of Lake Michigan has improved substantially since the 1960s and 1970s due to diversion of municipal and industrial treated wastewater discharges away from Lake Michigan to the Des Plaines River Basin. Discharges along the Illinois shore now consist primarily of cooling water and some combined sewer overflows. Major sources of pollutants along the Illinois shore of Lake Michigan are atmospheric deposition, urban runoff and in-place contaminants.

Table 1 presents parameters evaluated along with appropriate standards, percent violations and mean concentrations in 1987. Total phosphate continues to be the major water quality problem although levels have substantially decreased since the 1970s. Current phosphate levels indicate oligotrophic conditions. Open lake and beach fecal coliform levels generally indicate excellent conditions for swimming. There continues to be a health advisory regarding consumption of Lake Michigan trout and salmon with lengths over 23 inches and 32 inches, respectively.

Table 1. Percent violations of water quality standards for the southwest portion of Lake Michigan, 1987.

Parameter (a)	Standard	Number of Samples	Percent Violation	Mean Concentration	Standard Deviation
Ammonia Nitrogen (mg/L)	0.02 (b)	182	7.7	0.01	0.03
Total Phosphate (mg/L)	0.02 (b)	182	33.5	0.02	0.01
Chloride (mg/L)	12.0 (b)	182	1.6	9.4	0.9
Sulfate (mg/L)	24.0 (b)	182	14.8	21.3	2.2
pH (units)	7.0-9.0 (b)	182	0.0	8.4	0.1
Conductivity (uS/cm)	300 (b,f)	182	8.2	290	11
Fecal Coliform, lake (#/100mL)	20 (b)	182	1.6	<1(g)	5
Fecal Coliform, beach (#/100mL)	200/400(e,h)/500(c)	4486	0.0/3.1/0.5	16(g)	-
Phenols (ug/L)	1.0 (d)	102	15.7	<1	1
Cyanide (mg/L)	0.025 (b)	18	0.0	<0.005	0.000
Fluoride (mg/L)	1.4 (e)	6	0.0	0.16	0.01
Total Arsenic (ug/L)	50 (d)	18	0.0	<1	1
Total Barium (ug/L)	1000 (d)	18	0.0	19	3
Total Boron (ug/L)	1000 (e)	18	0.0	<50	0
Total Cadmium (ug/L)	10 (d)	18	0.0	<3	0
Total Chromium (ug/L)	50 (d)	18	0.0	<9	6
Total Copper (ug/L)	20 (e)	18	0.0	<5	0
Total Iron (ug/L)	1000 (e)	18	0.0	<60	23
Total Lead (ug/L)	50 (d)	18	0.0	<50	0
Total Manganese (ug/L)	150 (d)	18	0.0	<6	2
Total Mercury (ug/L)	0.5 (e)	17	0.0	<0.05	0.00
Total Nickel (ug/L)	1000 (e)	18	0.0	<7	4
Total Silver (ug/L)	5.0 (e)	18	5.5	<3	1
Total Zinc (ug/L)	1000 (e)	18	0.0	<50	0
Aldrin (ug/L)	1.0 (d)	3	0.0	<0.001	0.000
Dieldrin (ug/L)	1.0 (d)	3	0.0	0.001	0.000
Endrin (ug/L)	0.2 (d)	3	0.0	<0.001	0.000
Total DDT (ug/L)	50.0 (d)	3	0.0	<0.001	0.000
Total Chlordane (ug/L)	3.0 (d)	3	0.0	<0.004	0.001
Methoxychlor (ug/L)	100 (d)	3	0.0	<0.005	0.000

(a) Fecal coliform (beach) data are from 51 Illinois beaches; cyanide, metals and pesticides data are from JWPP & SWPP surveys; remaining parameters are from Open Water, North Shore and South Shore surveys.
(b) Lake Michigan Standard (35 IL Adm. Code 302)
(c) Criterion for closing beaches - consecutive samples >500/100mL (IDPH,1987)
(d) Public and Food Processing Water Supply Standard (35 IL Adm. Code 302)
(e) General Use Standard (35 IL Adm. Code 302)
(f) Conductivity x 0.6 = Total Dissolved Solids (IEPA, 1986; Torrey,1976)
(g) Geometric Mean
(h) Geometric mean shall not exceed 200 and no more than 10% of samples shall exceed 400.

TOTAL COLIFORM (Figure 8; page 43)

Although there is no standard for total coliform, it is a good indicator of water quality. Total coliform counts in 1987 ranged from 0 to 168/100 mL with mean values of 4/100 mL, 3/100 mL and 11/100 mL for Open Water, North Shore and South Shore Surveys respectively. Total coliform counts have substantially decreased from those found in the 1970s, especially along the South Shore. South Shore annual means during that period ranged from 200 to 1300/100 mL.

FECAL COLIFORM (Figure 9; page 45)

Fecal coliform counts in 1986 ranged from 0 to 44/100 mL. Five percent of the South Shore samples exceeded the standard of 20/100 mL. The 1987 annual geometric means were 0/100 mL on the Open Water, < 1/100 mL on the North Shore and 1/100 mL on the South Shore Surveys. Annual geometric means for the past 19 years have been well below the 20/100 mL water quality standard. The highest geometric mean of 5/100 mL was for the South Shore in 1971.

AMMONIA NITROGEN (Figure 10; page 47)

Ammonia nitrogen concentrations in 1987 ranged from <0.01 mg/L to 0.32 mg/L. Fifteen percent of the South Shore samples exceeded the 0.02 mg/L standard compared to two percent in violation for the North Shore and five percent in violation for the Open Water Lake Survey. The respective annual means and standard deviations (± SD) concentrations for the Open Water, North Shore and South Shore Surveys were: 0.01 (± 0.01) mg/L, 0.01 (± 0.03) mg/L and 0.02 (± 0.04) mg/L. Ammonia mean concentrations have decreased substantially since the 1970s, especially along the South Shore where values ranged from 0.04 mg/L to 0.07 mg/L.

TOTAL PHOSPHATE (Figure 11; page 49)

Total phosphate concentrations in 1987 ranged from <0.01 mg/L to 0.07 mg/L. Twenty-nine percent of Open Water, 27% of North Shore and 44% of South Shore samples exceeded the 0.021 mg/L water quality standard. Annual mean (± SD) concentrations for Open Water, North Shore and South Shore Surveys were 0.02 (± 0.01) mg/L, 0.02 (± 0.02) mg/L and 0.02 (± 0.01) mg/L, respectively.. These values are substantially lower than those found in the early 1970s when values ranged from 0.04 mg/L to 0.10 mg/L.

CHLORIDE (Figure 12; page 51)

Chloride concentrations in 1987 ranged from 9 to 16 mg/L. Mean (± SD) concentrations were 9.2 (± 0.2) mg/L, 9.3 (± 0.4) mg/L and 10.0 (± 1.3) mg/L for Open Water, North Shore and South Shore Surveys, respectively. Five percent of South Shore samples exceeded the 12.0 mg/L water quality standard. Chloride annual mean concentrations have fluctuated over the past ten years, ranging from 8.1 mg/L to 10.7 mg/L. The highest concentrations have generally been detected along the South Shore.

SULFATE (Figure 13; page 52)

Sulfate concentrations in 1987 ranged from 17.8 mg/L to 27.8 mg/L. Annual mean (± SD) concentrations were 20.8 (± 1.0) mg/L for the Open Water, 21.0 (± 2.1) mg/L for the North Shore and 22.2 (±2.7) mg/L for the South Shore Lake Surveys. Thirteen percent of the North Shore samples, and 29% percent of South Shore samples exceeded the water quality standard of 24.0 mg/L. Although the violation rate in 1987 was considerably higher than the previous four years, annual means were fairly similar. Sulfate mean concentrations over the past ten years have fluctuated between 21 and 26 mg/L. South Shore levels have generally been higher than North Shore and Open Water concentrations. The only annual mean to exceed the water quality standard was in 1979 for the South Shore (25.5 mg/L).

PHENOLS

Concentrations of phenols in 1987 ranged from < 1 ug/L to 9 ug/L. Mean (±SD) concentrations were 1 (±1) ug/L for both North and South Shore Surveys. Open Water samples are not analyzed for phenols. Nineteen percent of North Shore samples and 14% of South Shore samples exceeded the 1.0 ug/L water quality standard. This is somewhat lower than what was found in 1986, but much higher compared to previous years. From 1979 to 1985 no violations were found, in 1978 one (0.6%) violation was found and in 1977 six (3.5%) were found. The reason for this increase is unclear, but a change in laboratory methodology in 1986 may be responsible.

CONDUCTIVITY

Conductivity levels in 1987 ranged from 275 uS/cm to 350 uS/cm. Mean (±SD) concentrations were 284 (±3) uS/cm, 288 (±6) uS/cm and 296 (±15) uS/cm for Open Water, North Shore, and South Shore Surveys, respectively. Eighteen percent of South Shore samples and 3% of North Shore samples exceeded 300 uS/cm (180 mg/L TDS). Conductivity levels have been relatively uniform over the last ten years.

TOXICS (Page 62)

Dieldrin and total chlordane were the only organochlorine compounds detected in 1987 water samples. Dieldrin was detected in all three samples (0.001 - 0.002 ug/L) and chlordane was detected in two of three samples (0.003 ug/L). Over the past eight years, dieldrin was detected in 2 of 36 samples (5.6%) and chlordane in 1 of 36 samples (2.8%). All concentrations were just above detection levels and considerably below Public and Food Processing Water Supply Standards.

The General Use Standard for total silver (5 ug/L) was exceeded in 1 of 18 water samples in 1987 with a concentration of 8 ug/L. Silver was not detected in 78% of the samples. This was the second violation of the silver standard out of 111 samples (1.8%) collected since 1981.

Cyanide, beryllium, boron, cadmium, lead, mercury and zinc were not detected in any samples in 1987. Detectable levels of arsenic, barium, chromium, copper, iron, manganese and nickel were well below water quality standards. These results are similar to those found since 1979.

FISH (Page 65)

There continues to be a health advisory regarding consumption of Lake Michigan sport fish. Excursions of U.S. Food and Drug Administration action levels for PCBs (2.0 mg/Kg) and chlordane (0.3 mg/Kg) in 1987 were found in Lake Trout over 28 inches, Chinook Salmon over 36 inches and Carp over 33 inches.

BEACH QUALITY (Page 72)

Fecal coliform counts at 51 beaches in 1987 ranged from < 1 to 18,200/100 mL with 3% of the samples exceeding 400/100 mL. The median geometric mean was 16/100 mL. None of the beaches had a geometric mean greater than the 200/100 mL General Use Standard. However, fecal coliform counts in excess of 400/100mL were found in more than 10% of the samples from Highland Park beach (23.7%) and Waukegan North beach (12.9%). The criterion for beach closure (consecutive samples > 500/100 mL) occurred 21 times (0.5%) in 1987, nine times at Highland Park, three times at Park Avenue, twice at Ohio Street and once each at Zion, Waukegan North, Waukegan Central, Lake Bluff, Highwood, Rosewood and Schiller beaches. Most of the excursions were found in August following heavy rainfall which resulted in numerous combined sewer overflows and severe flooding.

INTRODUCTION

The Great Lakes system is usually considered to be the largest (95,000 square miles) source of fresh surface water in the world, with the exception of the polar ice caps. Lake Michigan is the third largest of all the Great Lakes in area and it is the largest body of fresh water entirely within the boundaries of the United States.

As a natural resource of immeasurable value, Lake Michigan serves a broad spectrum of purposes. It provides drinking water for an estimated five million residents in the northeastern Illinois area. Its recreational opportunities attract fishing, boating, swimming and other water-oriented interests. The lake also serves as an avenue for domestic and international water-borne commerce. Industry and commerce have grown and developed giving the greater Chicago metropolitan area one the the largest industrial-commercial complexes in the United States. Consequently, some of Lake Michigan's water quality problems result from discharges of industrial and municipal wastes.

The City of Chicago has been conducting lake survey monitoring programs since the 1930's which have provided information on the condition of the Illinois waters of Lake Michigan. The number of surveys, parameters sampled and the degree of accuracy in which these analyses are performed has increased greatly over the years. With data gathered on a continuing basis, it has been possible to determine long term trends in lake water quality which show considerable improvement since 1970.

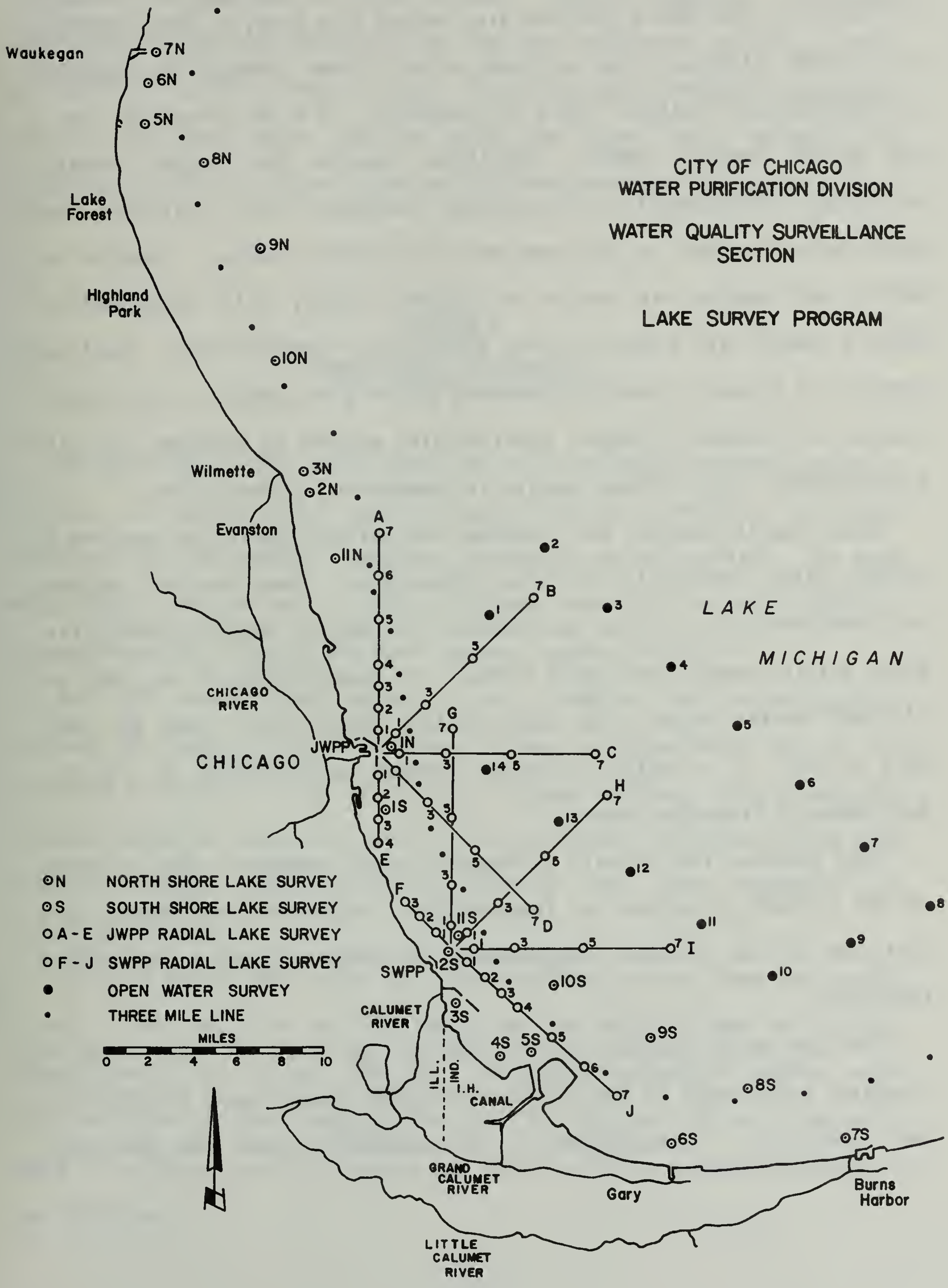
Recognizing the great importance of Lake Michigan as a natural asset, the 75th Illinois General Assembly authorized the Illinois Environmental Protection Agency to "... regularly conduct water quality and lake bed surveys to evaluate the ecology and quality of water in Lake Michigan". Since 1977 the Illinois portion of Lake Michigan has been monitored under the terms of a cooperative agreement between the City of Chicago and the Illinois Environmental Protection Agency. This annual report is the product of that joint agreement.

METHODS

The lake survey program is conducted by the City of Chicago's Water Quality Surveillance Section and consists of eighty sample stations on five separate surveys: fourteen on the Chicago-Lake Michigan Open Water Survey, ten on the North Shore Survey, eleven on the South Shore Survey, twenty-three on the JWPP Radial Survey and twenty-two on the SWPP Radial Survey (Figure 1). Since 1977, a typical survey season has consisted of 20 to 24 sampling surveys. Surveys are conducted from January through December each year providing there are no weather related problems.

The lake surveys are conducted from the 85 foot, round hull, 26 gross ton Chicago Water Department tugboat, the James J. Versluis. Water samples are drawn through an intake pipe mounted on the port aft gunnel. The intake orifice is approximately three feet below the water surface and the water samples are collected while the tug is in motion, utilizing a small impeller pump. The water is delivered to a sampling sink tap located within the stern cabin. This arrangement allows the surveys to be conducted during inclement weather, providing lake conditions are not too adverse.

Figure 1. Locations of Lake Survey stations.



The location of sampling stations for the lake survey program are shown in Figure 1. The sample stations are located by a buoy, a shore sighting or a timed distance from a fixed point. Three samples are normally collected at each station: an 8 oz. bacterial, an 8 oz. microscopy and a one gallon chemical sample. Additional samples for cyanide, metals, pesticides, chlorophyll and asbestos analyses are collected from pre-selected stations on the Open Water and Radial Surveys. Samples for metals and cyanide are placed in plastic bottles with preservatives. Mercury samples are placed in glass bottles with preservatives. Pesticide samples are placed in specially prepared gallon glass bottles. Chlorophyll samples are placed in plastic quart bottles wrapped in aluminum foil with preservatives. All of these samples are immediately stored on ice.

Water quality samples are processed and analyzed mainly by the City of Chicago Water Purification Division Laboratories. Some selected analyses are performed by Illinois Environmental Protection Agency Laboratories. Water quality samples are split between the laboratories at six JWPP and six SWPP Radial Survey sites approximately two to four times per year. This is part of a quality assurance program as prescribed by the U.S. Environmental Protection Agency.

Fish samples, for analysis of organochlorine compounds, were collected by the Illinois Department of Conservation. Analysis of the samples were performed by the Illinois Environmental Protection Agency's Springfield Laboratory.

The lake water quality is evaluated on the basis of water quality standards promulgated by the Illinois Pollution Control Board (IPCB) (35 IL Adm. Code 302). A description of the parameters along with applicable standards are provided in the glossary. Survey data are collected, evaluated and presented separately for the five individual surveys as shown in Section A of this annual report. The three most frequently conducted surveys; the Open Water, and the North and South Shore Surveys, are evaluated for the multi-year water quality trend analyses in Section B.

SECTION A

OPEN WATER LAKE SURVEY

The Open Water Lake Survey began in 1977. The data from this survey is utilized to assess water quality away from the influence of shore discharges and to monitor long-term changes in water quality. The Open Water Survey consists of 14 stations located from 6 to 18 miles offshore between Evanston, Illinois and Burns Harbor, Indiana (Figure 2).

The 1987 annual mean values of all chemical and microbiological analyses for each of the 14 stations on the four Open Water Surveys are presented in Table 2. The all station minimum, maximum, annual mean and standard deviation values for each of the twenty-four parameters along with percent violation data for those parameters with IPCB standards are presented in Table 3.

The 1987 annual mean value for total coliform on the Open Water Lake Survey in 1987 was 4/100 mL. The means for the fourteen sampling stations ranged from 0 to 35 per 100 mL. Fifty-six individual samples were collected with results ranging from zero to 140 per 100 mL. Currently there is no water quality standard for total coliform bacterial levels in Lake Michigan.

Figure 2. Locations of Open Water Lake Survey stations.

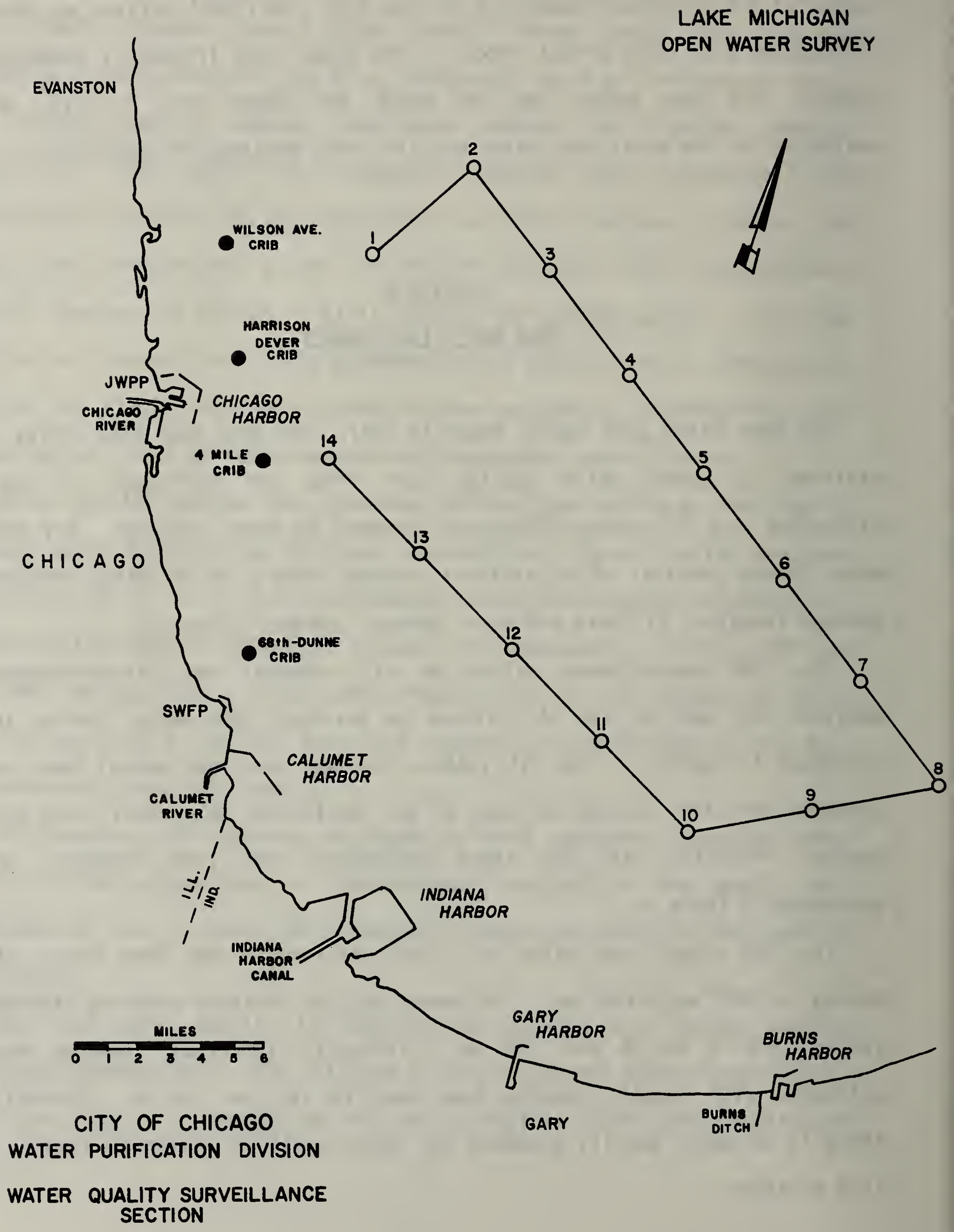


Table 2. **OPEN WATER LAKE SURVEY SUMMARY TABLE** - 1987

PARAMETER		STORET NUMBER	SURVEYS	ANNUAL MEAN													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
TURBIDITY	N.T.U.	00076	4	0.82	0.69	0.65	0.57	0.52	0.49	0.51	0.56	0.51	0.61	0.59	0.57	0.64	0.77
ODOR, THRESHOLD	T.O.N.	00086	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CONDUCTIVITY	µmhos	00095	4	284	283	286	286	285	285	285	284	284	285	283	283	283	284
OXYGEN DEMAND, CHEMICAL	mg/L	00335	4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
pH		00400	4	8.4	8.5	8.5	8.4	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530	4	3	2	2	2	2	2	3	2	2	2	1	1	2	2
RESIDUE, FILTRABLE	mg/L	00515	4	147	149	152	155	157	158	161	162	161	162	159	158	161	156
NITROGEN, ORGANIC	mg/L	00605	4	0.15	0.15	0.15	0.15	0.15	0.19	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.16
NITROGEN, AMMONIA	mg/L	00610	4	<0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01	0.01	0.01	<.01	<.01	0.01
NITROGEN, NITRITE-NITRATE	mg/L	00630	4	0.22	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
PHOSPHATE, TOTAL	mg/L	00650	4	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.02
PHOSPHATE, DISSOLVED	mg/L	00653	4	<.01	<.01	<.01	0.01	0.01	0.01	0.01	<.01	<.01	0.01	0.01	<.01	0.01	<.01
SODIUM	mg/L	00929	4	5.3	5.1	5.3	5.1	5.1	5.2	5.4	5.4	5.2	5.3	5.1	5.1	5.2	5.0
POTASSIUM	mg/L	00937	4	1.3	1.3	1.4	1.3	1.3	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.4
CHLORIDE	mg/L	00940	4	8.9	8.9	9.0	9.0	9.0	9.1	8.9	9.0	9.0	9.1	9.0	8.9	9.0	9.0
SULFATE	mg/L	00945	4	20.3	20.5	20.4	20.8	20.6	21.1	20.9	20.8	20.9	20.9	20.8	20.9	21.0	20.9
SILICA, SiO_2	mg/L	00956	4	0.13	0.16	0.16	0.18	0.18	0.20	0.20	0.20	0.20	0.18	0.16	0.16	0.16	0.13
ASBESTOS	fibers/L $X10^5$	00948	4	-	3.5	-	2.7	-	2.2	-	2.9	-	2.9	-	3.5	-	2.7
PLATE COUNT, 48hr.- 35°C	per mL	31753	4	5	12	9	7	11	3	5	5	6	4	2	3	2	4
COLIFORM, TOTAL	per 100 mL	31503	4	21	35	0	0	1	0	0	2	0	2	0	0	0	1
COLIFORM, FECAL	per 100 mL geo. mean	31616	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0
STREP, FECAL	per 100 mL	31679	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0
FUNGI	per mL	31856	4	1	0	0	0	1	0	0	1	1	0	1	0	1	2
ACTINOMYCETES	per mL	80148	4	1	1	1	1	1	0	1	0	1	1	1	0	1	[illegible]
PLANKTON	per mL	60050	4	323	285	720	263	218	278	308	248	300	270	263	210	225	233

Table 3. OWS ALL STATION WATER QUALITY SUMMARY - 1987

PARAMETER		STORET NUMBER	STANDARD	NO. OF SAMPLES	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	PERCENT VIOLATION
TURBIDITY	N.T.U.	00076		56	0.25	2.10	0.62	0.37	-
ODOR, THRESHOLD	T.O.N.	00086		56	1	2	1	0.3	-
CONDUCTIVITY	µmhos	00095		56	275	290	284	2.7	-
OXYGEN DEMAND, CHEMICAL	mg/L	00335		56	< 5	9.1	< 5	1.9	-
pH		00400	7.0-9.0	56	8.3	8.6	8.5	0.1	0
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530		56	0	5	2	1.5	-
RESIDUE, FILTRABLE	mg/L	00515	180	56	131	191	157	17	-
NITROGEN, ORGANIC	mg/L	00605		56	0.14	0.28	0.15	0.02	-
NITROGEN, AMMONIA	mg/L	00610	0.02	56	< 0.01	0.07	0.01	0.01	5
NITROGEN, NITRITE-NITRATE	mg/L	00630		56	0.17	0.30	0.23	0.03	-
PHOSPHATE, TOTAL	mg/L	00650	0.021	56	< 0.01	0.06	0.02	0.01	29
PHOSPHATE, DISSOLVED	mg/L	00653		56	< 0.01	0.03	0.01	0.01	-
SODIUM	mg/L	00929		56	4.4	6.6	5.2	0.5	-
POTASSIUM	mg/L	00937		56	1.2	1.7	1.3	0.2	-
CHLORIDE	mg/L	00940	12.0	56	8.5	9.4	9.2	0.2	0
SULFATE	mg/L	00945	24.0	56	19.2	22.5	20.8	1.0	0
SILICA, SiO_2	mg/L	00956		56	0.00	0.41	0.17	0.12	-
ASBESTOS	fibers/L $\times 10^5$	00948		27	0.47	5.22	2.91	1.47	-
PLATE COUNT, 48 hr.-35°C	per mL	31753		56	0	38	5	8	-
COLIFORM, TOTAL	per 100 mL	31503		56	0	140	4	21	-
COLIFORM, FECAL	per 100 mL geo. mean	31616	20 (a)	56	0	0	0	0	0
STREP, FECAL	per 100 mL	31679		30	0	2	0	0.4	-
FUNGI	per mL	31856		56	0	4	1	0.8	-
ACTINOMYCETES	per mL	80148		56	0	5	1	1	-
PLANKTON	per mL	60050		56	0	1440	297	340	-

The all station annual geometric mean for fecal coliform concentrations remained zero again in 1987. These concentrations have consistently been zero since the inception of the Open Water Lake Survey in 1977. None of the samples for fecal coliform in 1987 exceeded the water quality standard of 20/100 mL as promulgated by the IPCB.

The ammonia nitrogen all station annual mean in 1987 was 0.01 mg/L. Eight of the fourteen stations averaged >0.01 mg/L, five stations averaged <0.01 mg/L and station 5 averaged 0.02 mg/L. Sample values ranged from 0.01 to 0.07 mg/L with 5% of them in violation of the standard of 0.02 mg/L (Tables 2 and 3).

The total phosphate all station annual mean in 1987 was 0.02 mg/L. Ten of the stations averaged 0.02 mg/L and the remaining four were 0.01 mg/L (Table 2). Individual samples ranged from <0.01 mg/L to 0.06 mg/L with twenty-nine percent exceeding the 0.02 mg/L water quality standard.

Chloride annual means for individual sample stations were consistently low, from 8.9 to 9.1 mg/L (Table 2). The 1987 all station annual average was 9.2 mg/L. None of the 56 open water samples exceeded the chloride standard of 12.0 mg/L (Table 3).

The sulfate all station annual mean was 20.8 mg/L, with individual station averages ranging from 20.3 to 21.1 mg/L. None of the samples on the Open Water Survey, with values ranging from 19.2 to 22.5 mg/L in 1987, exceeded the sulfate standard.

NORTH SHORE LAKE SURVEY

The North Shore Lake Survey consists of ten stations, located between the City of Chicago's Jardine Water Purification Plant and Waukegan Harbor, Illinois. These ten stations, numbered 1N through 11N (station 4N was dropped), are located from one to four miles offshore (Figure 3).

In Illinois all sewage treatment plant effluents along the north shore have been diverted away from the lake. Factors that may affect local water quality include several small tributary streams, boat harbors, and discharges that consist primarily of cooling water and some combined sewer overflows.

Six North Shore Lake Surveys were completed in 1987 with data presented in Tables 4 and 5. Table 4 lists the annual means for all chemical and microbiological parameters for each of the ten north shore sample stations. Table 5 presents an all station minimum, maximum, annual mean and standard deviation values for all parameters, as well as percent violation for those having a water quality standard.

Microbiological analyses performed during 1987 indicated low total coliform levels. The all station annual arithmetic mean was 3 organisms per 100 mL (Table 5). The annual mean for individual sample stations ranged from zero to 15 organisms/100 mL (Table 4).

The 1987 all station annual geometric mean for fecal coliform was <1 organisms per 100 mL. None of the samples in 1987 exceeded the water quality standard for fecal coliform of 20 organisms per 100 mL. Sample station geometric means were 0/100 mL for all stations with the exception of 1N, near the Chicago Harbor Lighthouse with an annual mean of 1/100 mL. This NSLS data reflects good water quality with respect to microbiological conditions for the entire north shore.

The ammonia nitrogen all station annual mean was 0.01 mg/L, below the water quality standard of 0.02 mg/L. Individual sample station mean values ranged from <0.01 to 0.04 mg/L. The sixty individual samples collected on the NSLS during 1987 ranged from <0.01 to 0.20 mg/L, of these 2% were in violation of the standard (Table 5).

The all station annual mean for total phosphate was 0.02 mg/L The ten NSLS station means in 1987 ranged from 0.01 to 0.04 mg/L (Table 4). The 0.04 mg/L annual mean at station 1N was the only station in violation of the 0.021 mg/L water quality standard. Twenty-seven percent of the sixty samples, ranging from <0.01 to 0.07 mg/L, exceeded the total phosphate standard (Table 5).

The all station mean for chloride in 1987 was 9.3 mg/L. Chloride mean values for the ten North Shore Lake Survey stations ranged from 9.2 to 9.4 mg/L (Table 4). None of the NSLS samples exceeded the 12.0 mg/L chloride standard. Chloride values ranged from 8.9 to 11.0 mg/L at all stations (Table 5).

The all station annual mean for sulfate was 21.0 mg/L. Sulfate mean values for the ten North Shore Survey stations ranged from 20.7 to 21.3 mg/L. In 1987, 13% of the sulfate samples (ranging from 18.7 to 26.5 mg/L) on the North Shore Survey were in violation of the water quality standard of 24.0 mg/L (Table 5), compared to 1% in 1986. All of the violations in 1987 were found on September 9.

Figure 3. Locations of North Shore Lake Survey stations.

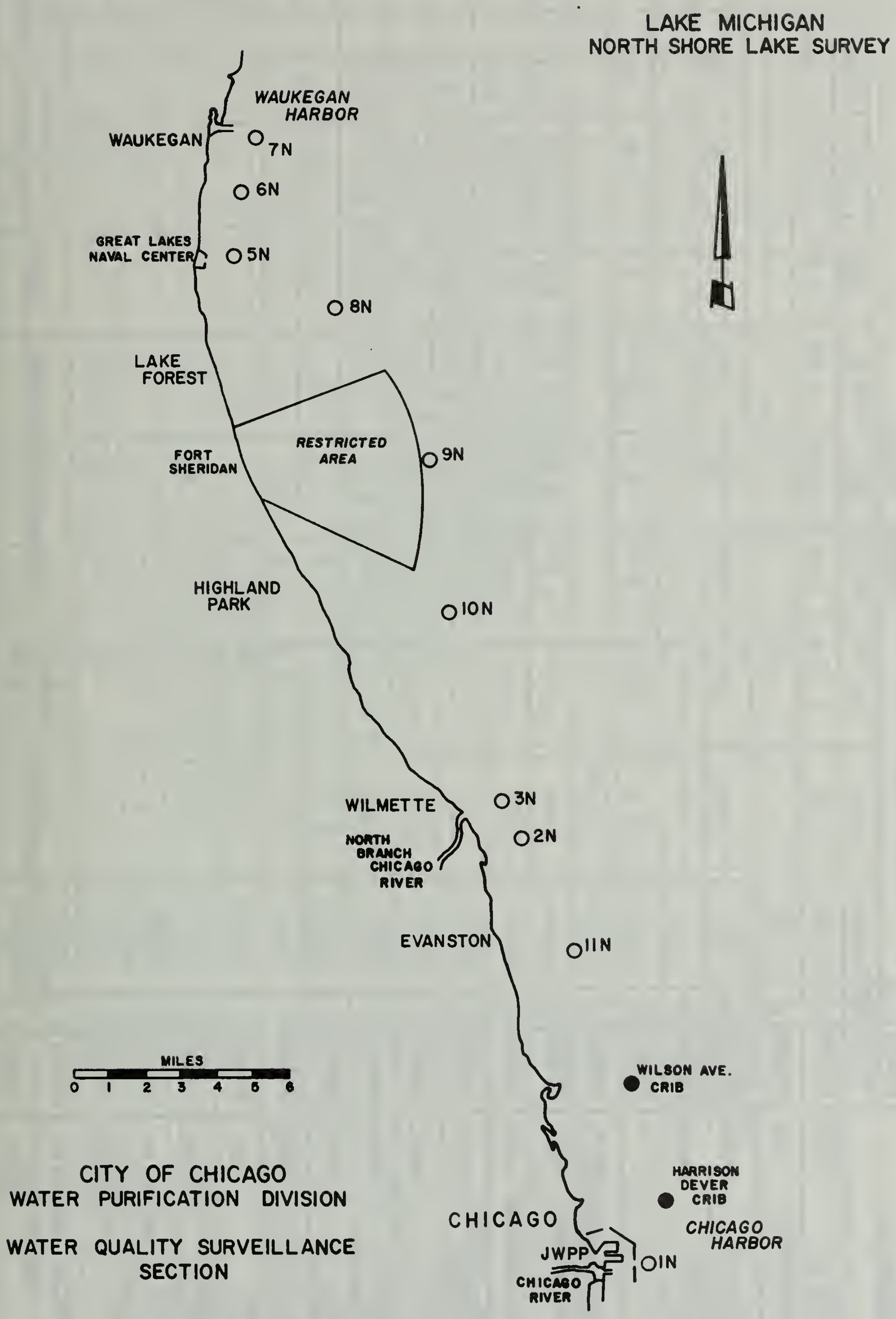


Table 4. **NORTH SHORE LAKE SURVEY SUMMARY TABLE** - 1987

PARAMETER	STORET NUMBER	SUR-VEYS	ANNUAL MEAN									
			1N	2N	3N	5N	6N	7N	8N	9N	10N	11N
TURBIDITY N.T.U.	00076	6	2.58	1.26	1.10	1.51	1.47	1.68	0.93	0.95	0.94	1.39
ODOR, THRESHOLD T.O.N.	00086	6	2	1	1	1	1	1	1	1	1	1
CONDUCTIVITY µmhos	00095	6	288	287	288	290	291	293	288	288	286	287
OXYGEN DEMAND, CHEMICAL mg/L	00335	6	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
pH	00400	6	8.4	8.4	8.4	8.4	8.4	8.4	8.5	8.5	8.4	8.4
RESIDUE, TOTAL NONFILTRABLE mg/L	00530	6	6	4	4	4	3	5	3	3	4	4
NITROGEN, ORGANIC mg/L	00605	6	0.19	0.17	0.17	0.17	0.16	0.17	0.17	0.16	0.17	0.17
NITROGEN, AMMONIA mg/L	00610	6	0.01	< 0.01	0.01	< 0.01	0.01	0.01	0.01	0.04	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	6	0.21	0.21	0.21	0.21	0.23	0.24	0.22	0.22	0.22	0.22
PHOSPHATE, TOTAL mg/L	00650	6	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02
PHOSPHATE, DISSOLVED mg/L	00653	6	0.02	< 0.01	< 0.01	0.01	0.01	0.01	< 0.01	0.01	< 0.01	0.01
CHLORIDE mg/L	00940	6	9.3	9.3	9.2	9.4	9.3	9.4	9.3	9.3	9.2	9.2
SULFATE mg/L	00945	6	21.0	20.7	21.2	20.8	21.2	21.1	20.8	21.2	20.8	21.3
PHENOL LIKE SUBSTANCES µg/L	32730	6	1	-	1	1	-	1	-	1	-	1
PLATE COUNT, 48hr.-35°C per mL	31753	6	55	20	14	11	15	21	8	6	12	14
COLIFORM, TOTAL per 100 mL	31503	6	15	1	0	2	2	1	0	0	1	4
COLIFORM, FECAL per 100 mL geo. mean	31616	6	1	0	0	0	0	0	0	0	0	0
STREP, FECAL per 100 mL	31679	6	0	0	0	0	0	0	1	0	0	3
FUNGI per mL	31856	6	0	1	0	1	1	1	0	0	0	1
ACTINOMYCETES per. mL	80148	6	2	1	2	2	3	3	1	2	2	2
PLANKTON per mL	60050	6	930	647	1435	848	853	983	913	667	1357	1097

Table 5. NSLS ALL STATION WATER QUALITY SUMMARY - 1987

PARAMETER		STORET NUMBER	STANDARD	NO. OF SAMPLES	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	PERCENT VIOLATION
TURBIDITY	N.T.U.	00076		60	0.35	6.20	1.38	1.30	-
ODOR, THRESHOLD	T.O.N.	00086		60	1	3	1	0.4	-
CONDUCTIVITY	µmhos	00095		60	280	305	288	6	-
OXYGEN DEMAND, CHEMICAL	mg/L	00335		60	< 5	7.8	< 5	2.2	-
pH		00400	7.0-9.0	60	8.3	8.5	8.4	0.1	0
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530		60	0	11	4	3	-
NITROGEN, ORGANIC	mg/L	00605		60	0.14	0.22	0.17	0.02	-
NITROGEN, AMMONIA	mg/L	00610	0.02	60	< 0.01	0.20	0.01	0.03	2
NITROGEN, NITRITE-NITRATE	mg/L	00630		60	0.17	0.34	0.22	0.03	-
PHOSPHATE, TOTAL	mg/L	00650	0.021	60	< 0.01	0.07	0.02	0.02	27
PHOSPHATE, DISSOLVED	mg/L	00653		60	< 0.01	0.04	0.01	0.01	-
CHLORIDE	mg/L	00940	12.0	60	8.9	11.0	9.3	0.4	0
SULFATE	mg/L	00945	24.0	60	18.7	26.5	21.0	2.1	13
PHENOL LIKE SUBSTANCES	µg/L	32730	1.0 (a)	36	< 1	3	1	1	19
PLATE COUNT, 48hr.-35°C	per mL	31753		60	0	110	18	24	-
COLIFORM, TOTAL	per 100 mL	31503		60	0	48	3	8	-
COLIFORM, FECAL	per 100 mL geo. mean	31616	20 (b)	60	0	8	0	<1	0
STREP, FECAL	per 100 mL	31679		60	0	18	0	2	-
FUNGI	per mL	31856		60	0	3	1	1	-
ACTINOMYCETES	per mL	80148		60	0	15	2	3	-
PLANKTON	per mL	60050		60	30	5200	973	1119	-

City of Chicago **Water Purification Division** **Water Quality Surveillance Section**

(a) Public and Food Processing Water Supply Standard (IPCB, 1982)

(b) Geometric Mean

SOUTH SHORE LAKE SURVEY

The South Shore Lake Survey consists of 11 stations numbered 1S through 11S located between Chicago's Burnham Harbor and Burns Harbor, Indiana, east of Gary. Stations 1S through 7S are within one mile of shore and are affected by shore discharges. Stations 8S through 11S are from two to six miles offshore and provide information on the indirect effects of discharges on the lake proper (Figure 4).

The shoreline covered by this survey includes approximately twenty miles of the most concentrated industrial areas in the nation, consisting predominately of petroleum refining and steel manufacturing. In Indiana, the Indiana Harbor Canal (IHC), the Calumet River and Burns Ditch receive industrial waste and treated wastewater, and discharge directly into the lake affecting water quality along the south shore (Figure 1).

Since over 90% of the water in the I.H.C. originates as treated wastewater, cooling water and storm water overflow from sewers, it is considered to be the main source of pollution in the southwestern basin of Lake Michigan (Indiana Stream Pollution Control Board, 1973). The effluents from steel mills, oil refineries and municipal sewage treatment plants often result in a plume of polluted water which flows from the harbor, causing occasional periods of degraded raw water quality at Chicago's South Water Purification Plant. This in turn requires additional costs for taste and odor removal and treatment processing.

The Calumet River and the Grand Calumet River usually flow inland, but may flow into Lake Michigan during periods of heavy precipitation. Flow at the mouth of the Calumet River is lakeward due to nearby discharges. The outward flow carries polluted Calumet Harbor water into the southern end of Lake Michigan, which has neither sufficient depth nor currents necessary to absorb and dilute the wastes.

Figure 4. Locations of South Shore Lake Survey stations.

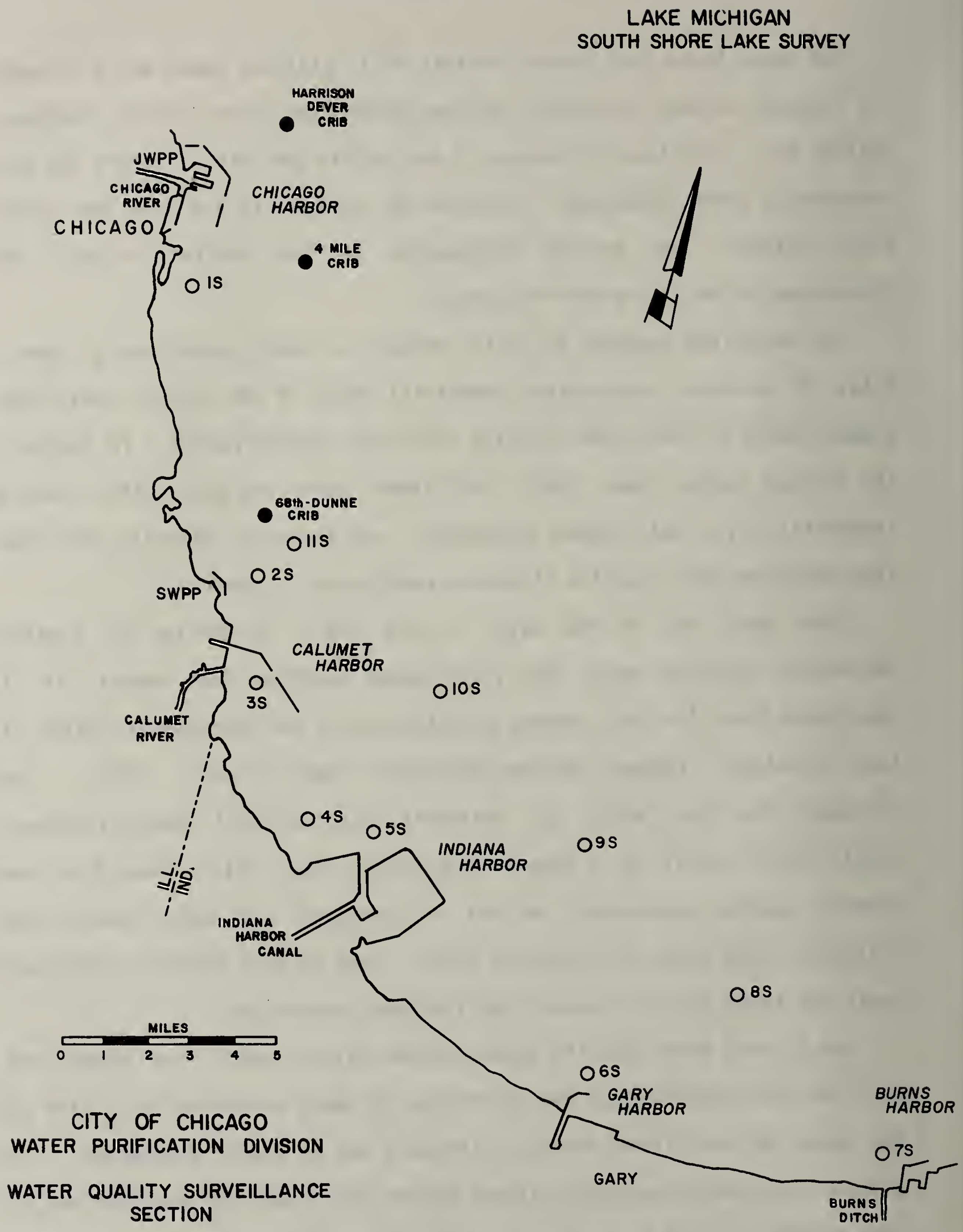


Table 6. **SOUTH SHORE LAKE SURVEY SUMMARY TABLE - 1987**

PARAMETER	STORET NUMBER	SUR-VEYS	ANNUAL MEAN										
			1S	2S	3S	4S	5S	6S	7S	8S	9S	10S	11S
TURBIDITY N.T.U.	00076	6	3.97	2.44	2.81	2.52	2.50	1.67	1.55	1.12	0.97	1.68	2.49
ODOR, THRESHOLD T.O.N.	00086	6	2	1	1	1	1	1	1	1	1	1	1
CONDUCTIVITY µmhos	00095	6	289	294	300	300	310	297	298	293	291	289	290
OXYGEN DEMAND, CHEMICAL mg/L	00335	6	< 5	< 5	< 5	< 5	< 5	< 5	5.1	< 5	< 5	< 5	< 5
pH	00400	6	8.4	8.4	8.4	8.4	8.4	8.5	8.5	8.5	8.5	8.5	8.5
RESIDUE, TOTAL NONFILTRABLE mg/L	00530	6	3	4	4	3	3	3	3	2	2	2	3
NITROGEN, ORGANIC mg/L	00605	6	0.13	0.14	0.14	0.15	0.15	0.14	0.14	0.16	0.14	0.15	0.13
NITROGEN, AMMONIA mg/L	00610	6	0.01	0.02	0.02	0.02	0.06	0.01	0.01	0.01	0.01	<0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	6	0.22	0.24	0.26	0.27	0.33	0.26	0.28	0.27	0.25	0.25	0.25
PHOSPHATE, TOTAL mg/L	00650	6	0.04	0.02	0.03	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.02
PHOSPHATE, DISSOLVED mg/L	00653	6	0.01	0.01	0.01	< 0.01	0.01	< 0.01	0.01	<0.01	<0.01	0.01	0.01
CHLORIDE mg/L	00940	6	9.8	9.9	10.7	10.4	11.1	9.7	10.0	9.8	9.5	9.7	9.5
SULFATE mg/L	00945	6	21.0	21.6	22.7	23.0	23.9	22.1	22.6	22.0	21.6	21.7	21.7
PHENOL LIKE SUBSTANCES µg/L	32730	6	2	1	< 1	1	< 1	< 1	2	< 1	< 1	1	1
PLATE COUNT, 48hr.-35°C per mL	31753	6	27	60	175	1808	5884	401	3318	66	17	27	35
COLIFORM, TOTAL per 100 mL	31503	6	3	8	8	21	30	6	38	1	0	2	1
COLIFORM, FECAL per 100 mL geo. mean	31616	6	0	1	1	1	2	0	2	0	0	0	0
STREP, FECAL per 100mL	31679	6	0	1	3	0	0	0	0	0	1	0	0
FUNGI per mL	31856	6	0	0	0	1	1	1	2	0	0	0	1
ACTINOMYCETES per mL	80148	6	1	1	1	2	1	2	3	2	1	1	1
PLANKTON per mL	60050	6	345	468	690	502	362	672	602	538	575	488	335

Table 7. SSLS ALL STATION WATER QUALITY SUMMARY - 1987

PARAMETER	STORET NUMBER	STANDARD	NO. OF SAMPLES	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	PERCENT VIOLATION
TURBIDITY N.T.U.	00076		66	0.35	17.00	2.16	2.65	-
ODOR, THRESHOLD T.O.N.	00086		66	1	2	1.1	0.3	-
CONDUCTIVITY µmhos	00095		66	275	350	296	15	-
OXYGEN DEMAND, CHEMICAL mg/L	00335		66	<5	13.8	<5	3.4	-
pH	00400	7.0-9.0	66	8.3	8.5	8.4	0.7	0
RESIDUE, TOTAL NONFILTRABLE mg/L	00530		66	0	10	3	2	-
NITROGEN, ORGANIC mg/L	00605		66	0.06	0.21	0.15	0.04	-
NITROGEN, AMMONIA mg/L	00610	0.02	66	<0.01	0.32	0.02	0.04	15
NITROGEN, NITRITE-NITRATE mg/L	00630		66	0.16	0.52	0.26	0.07	-
PHOSPHATE, TOTAL mg/L	00650	0.021	66	<0.01	0.05	0.02	0.01	44
PHOSPHATE, DISSOLVED mg/L	00653		66	<0.01	0.03	0.01	0.01	-
CHLORIDE mg/L	00940	12.0	66	8.7	15.5	10.0	1.3	5
SULFATE mg/L	00945	24.0	66	17.8	27.8	22.2	2.7	29
PHENOL LIKE SUBSTANCES µg/L	32730	1.0 (a)	66	<1	9	1	1.5	14
PLATE COUNT, 48hr.-35°C per mL	31753		66	2	29,000	1074	4246	-
COLIFORM, TOTAL per 100 mL	31503		66	0	168	11	29	-
COLIFORM, FECAL per 100 mL geo. mean	31616	20 (b)	66	0	44	1	2	5
STREP, FECAL per 100 mL	31679		66	0	8	1	2	-
FUNGI per mL	31856		66	0	3	1	1	-
ACTINOMYCETES per mL	80148		66	0	6	1	2	-
PLANKTON per mL	60050		66	0	2400	507	504	-

City of Chicago Water Purification Division Water Quality Surveillance Section

(a) Public and Food Processing Water Supply Standard (IPCB, 1982)

(b) Geometric Mean

Chemical and microbiological mean values for the eleven stations sampled on the six South Shore Lake Surveys performed during 1987 are summarized in Table 6. The minimum, maximum, annual mean and standard deviation for all parameters analyzed and percent violation for those parameters are listed in Table 7.

As observed in previous years on the South Shore Lake Survey (SSLS), the highest bacterial concentrations were found at station 3S through 7S along the Calumet, Indiana, Gary and Burns Harbor areas.

In 1987, stations 3S through 7S contributed approximately 87% of the total coliform counts, with 4S and 5S accounting for 85% alone. These continually high nearshore values indicate the relative pollution load from the industrial complexes in this area. The 1987 all station annual mean for total coliform was 11/100 mL, with 5 of the 11 stations averaging from 0 to 3/100 mL (Table 6).

The 1987 all station geometric mean for fecal coliform was 1/100 mL, well below the IPCB water quality geometric mean standard of 20/100 mL. Annual geometric means for 5 individual stations were either 1 or 2/100 mL and the remaining six stations were zero. Five percent of all SSLS samples in 1987 exceeded the water quality standard for fecal coliform (Table 7).

The 1987 all station mean ammonia nitrogen concentration was 0.02 mg/L. The annual means for the eleven sample stations ranged from <0.01 to 0.06 mg/L. Site 5S was the only sample station to exceed the 0.02 mg/L water quality standard for ammonia nitrogen (Table 6). Individual ammonia nitrogen sample values ranged from <0.01 to 0.32 mg/L with 15% of the 66 samples in excess of the standard.

The annual mean for total phosphate was 0.02 mg/L. Individual stations averaged from 0.01 to 0.04 mg/L, with station 1S (0.04 mg/L), 3S (0.03 mg/L) and 5S (0.03 mg/L) exceeding the water quality standard of 0.021 mg/L. Individual samples (66) had total phosphate values ranging from <0.01 to 0.05 mg/L; 44% of these were in violation of the standard (Table 7).

Chloride samples collected in 1987 ranged from 8.7 to 15.5 mg/L, with an annual mean of 10.0 mg/L. The station mean values ranged from 9.5 to 11.1 mg/L. Five percent of the SSLS samples collected in 1987 were in violation of the 12 mg/L chloride standard.

The 1987 all station annual mean for sulfate was 22.2 mg/L. Individual station averages ranged from 21.0 to 23.9 mg/L (Table 6). Sulfate concentrations ranged from 17.8 to 27.8 mg/L, with 29% of the samples in violation of the 24.0 mg/L water quality standard. Most of the violations (79%) were found on March 24 and September 16.

Based on water quality at stations 4S and 5S, it appears that the Indiana Harbor Canal contributes the highest pollution load to the southwestern basin of Lake Michigan. Mean values for station 5S were higher than all the other stations during 1987 for fecal coliform, ammonia nitrogen, chloride and sulfate (Table 6).

JARDINE WATER PURIFICATION PLANT RADIAL LAKE SURVEY

The JWPP Radial Lake Survey consists of 23 stations located along five radii projecting out from an axis point at the Chicago Harbor Lighthouse, just east of the Jardine Water Purification Plant (Figure 5). The survey is intended to assess the water quality within a 10 mile radius of the Jardine Water Purification Plant.

Figure 5. Locations of Jardine Water Purification Plant Radial Survey stations

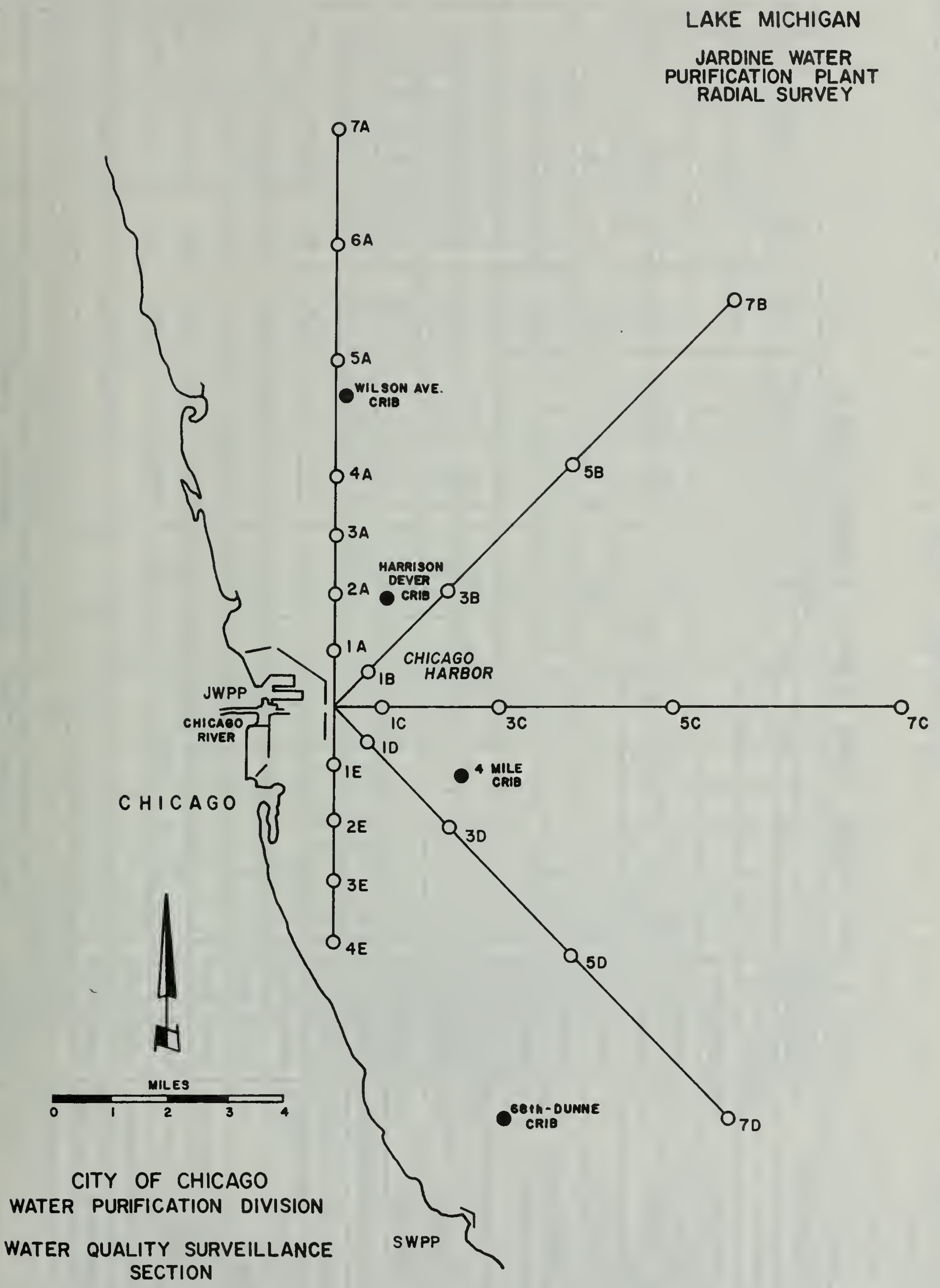


Table 8. **JWPP RADIAL LAKE SURVEY SUMMARY TABLE** - 1987

PARAMETER		STORET NUMBER	SUR-VEYS	ANNUAL MEAN										
				1A	2A	3A	4A	5A	6A	7A	1B	3B	5B	7B
TURBIDITY	N.T.U.	00076	3	1.20	1.08	1.05	0.98	0.92	0.97	0.92	0.92	0.87	0.77	0.72
ODOR, THRESHOLD	T.O.N.	00086	3	1	1	1	1	1	1	1	1	1	1	1
CONDUCTIVITY	µmhos	00095	3	283	283	287	287	282	282	285	283	283	287	282
OXYGEN DEMAND, CHEMICAL	mg/L	00335	3	<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
pH		00400	3	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530	3	4	4	4	3	3	4	3	3	2	2	3
NITROGEN, ORGANIC	mg/L	00605	3	0.17	0.17	0.17	0.17	0.17	0.17	0.21	0.17	0.17	0.17	0.17
NITROGEN, AMMONIA	mg/L	00610	3	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.02	0.02	0.02	0.02
NITROGEN, NITRITE-NITRATE	mg/L	00630	3	0.24	0.24	0.25	0.24	0.24	0.24	0.24	0.24	0.23	0.23	0.24
PHOSPHATE, TOTAL	mg/L	00650	3	0.04	0.01	0.03	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.02
PHOSPHATE, DISSOLVED	mg/L	00653	3	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01
CHLORIDE	mg/L	00940	3	9.2	9.2	9.3	9.2	9.4	9.4	9.4	9.4	9.0	9.0	9.0
SULFATE	mg/L	00945	3	21.1	21.3	21.6	21.4	21.3	21.5	21.4	21.4	21.3	21.5	21.1
PHENOL LIKE SUBSTANCES	µg/L	32730	1	-	-	-	-	1	-	-	-	-	3	-
IRON	µg/L	01045	3	31	26	<10	<10	13	24	18	14	<10	<10	<10
PLATE COUNT, 48 HR.- 35°C	per mL	31753	3	2016	1517	2814	804	704	4668	401	344	5	4	3
COLIFORM, TOTAL	per 100 mL	31503	3	5	1	1	2	0	1	3	2	1	0	0
COLIFORM, FECAL	per 100 mL geo. mean	31616	3	1	0	0	0	0	0	0	1	0	0	1
STREP, FECAL	per 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-
FUNGI	per mL	31856	3	1	0	0	0	1	1	1	1	0	0	2
ACTINOMYCETES	per mL	80148	3	1	1	1	1	1	1	1	0	1	1	1
PLANKTON	per mL	60050	3	820	-	847	-	1280	-	270	1170	687	410	760

Table 8. (Continued) JWPP RADIAL LAKE SURVEY SUMMARY (cont'd) - 1987

PARAMETER	STORET NUMBER	SURVEYS	ANNUAL MEAN											
			1C	3C	5C	7C	1D	3D	5D	7D	1E	2E	3E	4E
TURBIDITY N.T.U.	00076	3	0.92	0.88	0.78	0.68	1.05	0.88	0.88	0.92	1.23	1.00	1.15	1.15
ODOR, THRESHOLD T.O.N.	00086	3	1	1	1	1	1	1	1	1	1	1	1	1
CONDUCTIVITY µmhos	00095	3	282	285	283	285	283	287	287	280	287	280	285	282
OXYGEN DEMAND, CHEMICAL mg/L	00335	3	<5	<5	<5	<5	<5	<5	<5	<5	5.4	<5	14.7	7.7
pH	00400	3	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
RESIDUE, TOTAL NONFILTRABLE mg/L	00530	3	2	2	2	2	3	2	2	2	3	2	2	3
NITROGEN, ORGANIC mg/L	00605	3	0.17	0.17	0.17	0.18	0.19	0.17	0.18	0.17	0.18	0.19	0.19	0.19
NITROGEN, AMMONIA mg/L	00610	3	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	3	0.22	0.21	0.22	0.22	0.21	0.21	0.21	0.22	0.22	0.22	0.24	0.24
PHOSPHATE, TOTAL mg/L	00650	3	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.03	0.01	0.01	0.02
PHOSPHATE, DISSOLVED mg/L	00653	3	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01
CHLORIDE mg/L	00940	3	9.2	9.2	9.2	9.4	9.0	9.1	9.1	9.1	9.3	9.3	9.3	9.2
SULFATE mg/L	00945	3	21.4	21.3	21.4	21.2	21.5	21.6	21.7	21.9	21.7	21.8	22.1	21.7
PHENOL LIKE SUBSTANCES µg/L	32730	1	-	-	<1	-	-	-	2	-	-	-	-	<1
IRON µg/L	01045	3	16	<10	12	30	12	<10	<10	15	25	<10	17	15
PLATE COUNT, 48 HR. - 35°C per mL	31753	3	12	2	1	3	4	2	5	3	6	11	3	10
COLIFORM, TOTAL per 100 mL	31503	3	2	0	0	1	4	1	0	0	1	2	1	1
COLIFORM, FECAL per 100 mL geo. mean	31616	3	0	0	0	0	0	0	0	0	0	0	0	0
STREP, FECAL per 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-
FUNGI per mL	31856	3	0	0	0	0	0	0	0	0	1	1	0	0
ACTINOMYCETES per mL	80148	3	0	0	1	1	0	0	1	0	0	1	0	0
PLANKTON per mL	60050	3	1253	677	550	500	1442	653	770	560	1500	-	2047	-

Table 9. JWPP ALL STATION WATER QUALITY SUMMARY - 1987

PARAMETER		STORET NUMBER	STANDARD	NO. OF SAMPLES	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	PERCENT VIOLATION
TURBIDITY	N.T.U.	00076	-	69	0.30	2.10	0.95	0.4	-
ODOR, THRESHOLD	T.O.N.	00086		69	1	2	1	0.1	-
CONDUCTIVITY	µmhos	00095		69	270	295	284	6.8	-
OXYGEN DEMAND, CHEMICAL	mg/L	00335		69	< 5	21.3	6.1	2.7	-
pH		00400	7.0-9.0	69	8.4	8.5	8.4	0.05	0
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530		69	0	6	3	1.8	-
NITROGEN, ORGANIC	mg/L	00605		69	0.10	0.28	0.18	0.04	-
NITROGEN, AMMONIA	mg/L	00610	0.02	69	< 0.01	0.05	0.02	0.01	17
NITROGEN, NITRITE-NITRATE	mg/L	00630		69	0.16	0.31	0.23	0.04	-
PHOSPHATE, TOTAL	mg/L	00650	0.021	69	< 0.01	0.07	0.02	0.01	13
PHOSPHATE, DISSOLVED	mg/L	00653		69	< 0.01	0.03	< 0.01	0.007	-
CHLORIDE	mg/L	00940	12.0	69	8.6	10.4	9.2	0.3	0
SULFATE	mg/L	00945	24.0	69	19.5	24.2	21.5	1.3	1
PHENOL LIKE SUBSTANCES	µg/L	32730	1.0 (b)	5	< 1	3	1	1.3	40
IRON	µg/L	01045	1000 (a)	69	<10	89	19	16	-
PLATE COUNT, 48hr.-35°C	per mL	31753		69	0	14000	585	2151	-
COLIFORM, TOTAL	per 100 mL	31503		69	0	12	1	2	-
COLIFORM, FECAL	per 100 mL geo. mean	31616	20 (c)	69	0	4	0	1	0
STREP, FECAL	per 100 mL	31679		0	-	-	-	-	-
FUNGI	per mL	31856		69	0.4	0	5	0.8	-
ACTINOMYCETES	per mL	80148		69	0	4	1	1	-
PLANKTON	per mL	60050		54	0	3800	900	957	-

(a) General Use Standard (IPCB, 1982)
(b) Public and Food Processing Water Supply Standard (IPCB, 1982)
(c) Geometric Mean

Annual means for each of the parameters at the 23 sampling stations are presented in Table 8. All station results listing minimum, maximum, mean, standard deviation and percent violation are presented in Table 9.

Average total coliform bacterial levels in 1987 indicate water of high quality. The all station annual arithmetic mean was one organisms per 100 mL. Individual station means ranged from 0/100 mL at 7 of 23 stations to 5/100 mL at station 1A (Table 8). Since 1980 the JWPP all station annual means have ranged from one to three organisms/100 mL.

Individual station annual geometric means for fecal coliform in 1987 were zero except at station 1A (1/100 mL), 1B (1/100 mL) and 7B (1/100 mL). The water quality standard for fecal coliform is 20/100 mL. None of the JWPP Radial samples have exceeded the standard since 1982.

The all station annual mean for ammonia nitrogen was 0.02 mg/L. Mean values for the 23 stations ranged from 0.01 to 0.03 mg/L. Sample stations 1A (0.02 mg/L) and 4A (0.03 mg/L) annual means exceeded the water quality standard Of 0.02 mg/L. Individual ammonia nitrogen samples ranged from <0.01 mg/L to 0.05 mg/L, with 17% in violation of the water quality standard.

The all station annual mean for total phosphate in 1987 was 0.02 mg/L. Station means ranged from 0.01 to 0.04 mg/L. Three of the 23 sample stations had mean concentrations exceeding the 0.021 mg/L total phosphate standard. All of these stations are within a three mile radius of the Chicago Harbor Lighthouse (Table 8 and Figure 5). Individual sample values ranged from <0.01 to 0.07 mg/L with 13% in violation of the water quality standard (Table 9).

The 1987 chloride all station annual average was 9.2 mg/L, with station averages ranging from 9.0 to 9.4 mg/L (Table 8). None of 69 samples, ranging from 9.0 to 10.0 mg/L, were in violation of the 12.0 mg/L chloride standard.

The 1987 annual mean for sulfate was 21.5 mg/L. Station averages ranged from 21.1 to 22.1 mg/L. One percent of the samples, ranging from 20.0 to 24.0 mg/L, were in violation of the 24.0 mg/L sulfate standard.

SOUTH WATER PURIFICATION PLANT RADIAL LAKE SURVEY

The SWPP Radial Lake Survey consists of 22 stations located along five radii projecting out of an axis point near the South Water Purification Plant (Figure 6). The purpose of this survey is to assess the water quality within a 10 mile radius of the South Water Purification Plant.

Water quality within the survey area is largely determined by discharges from the Calumet-Indiana industrial area. Meteorological conditions determine to what extent the Indiana Harbor Canal and other shore discharges extend into Lake Michigan. Radii "F" and "J" usually exhibit higher average bacterial and chemical levels than the other radii due to their close proximity to these discharges. Station mean values are presented in Table 10. A summary of chemical and microbiological analyses on the three SWPP Radial Lake Surveys in 1987 is presented in Table 11.

Figure 6. Location of South Water Purification Plant Radial Survey stations.

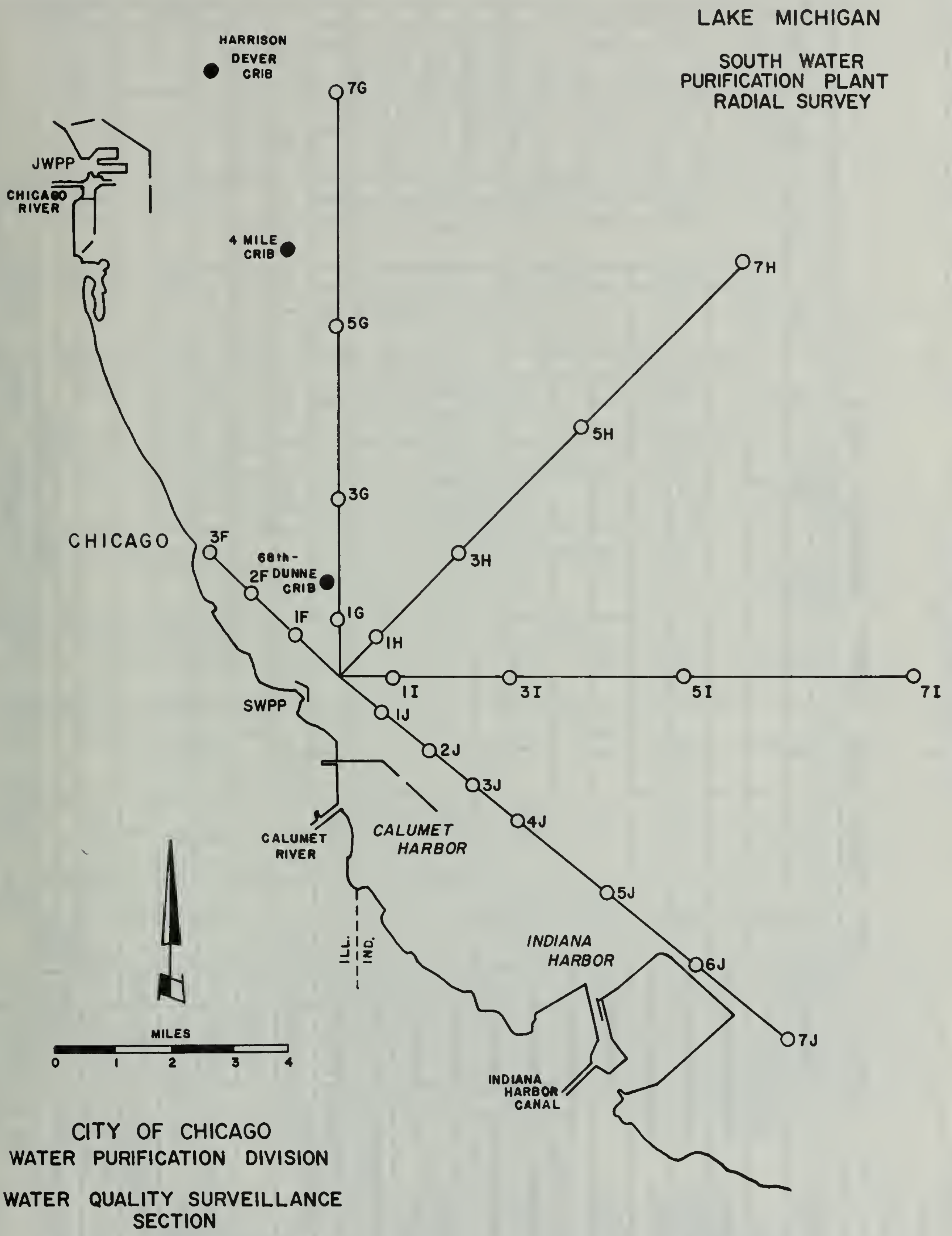


Table 10. **SWPP RADIAL LAKE SURVEY SUMMARY TABLE** - 1987

PARAMETER		STORET NUMBER	SUR-VEYS	ANNUAL MEAN										
				1F	2F	3F	1G	3G	5G	7G	1H	3H	5H	7H
TURBIDITY	N.T.U.	00076	3	0.80	0.87	1.03	0.80	0.78	0.67	0.77	0.82	0.70	0.63	0.65
ODOR, THRESHOLD	T.O.N.	00086	3	1	1	1	1	-	1	1	1	1	1	1
CONDUCTIVITY	µmhos	00095	3	288	287	287	282	283	283	282	282	282	278	282
OXYGEN DEMAND, CHEMICAL	mg/L	00335	3	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
pH		00400	3	8.4	8.4	8.4	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530	3	2	3	2	2	2	2	3	3	1	2	3
NITROGEN, ORGANIC	mg/L	00605	3	0.16	0.16	0.16	0.15	0.18	0.16	0.15	0.15	0.15	0.15	0.16
NITROGEN, AMMONIA	mg/L	00610	3	0.09	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.04
NITROGEN, NITRITE - NITRATE	mg/L	00630	3	0.21	0.22	0.23	0.22	0.22	0.22	0.22	0.23	0.22	0.22	0.22
PHOSPHATE, TOTAL	mg/L	00650	3	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
PHOSPHATE, DISSOLVED	mg/L	00653	3	0.01	0.01	<0.01	0.01	< 0.01	0.01	0.01	0.01	< 0.01	0.01	< 0.01
CHLORIDE	mg/L	00940	3	9.3	9.5	9.3	9.2	9.2	9.1	9.2	9.3	9.0	9.0	8.9
SULFATE	mg/L	00945	3	22.1	22.6	23.0	23.0	23.2	23.0	23.2	23.4	23.2	23.3	23.1
PHENOL LIKE SUBSTANCES	µg/L	32730	1	-	-	5	-	-	< 1	-	-		< 1	-
IRON	µg/L	01045	3	< 10	14	21	23	18	15	22	24	17	11	26
PLATE COUNT, 48 HR. - 35°C	per mL	31753	3	18	29	32	21	26	17	17	38	14	13	2
COLIFORM TOTAL	per 100 mL	31503	3	4	3	3	2	3	1	3	1	1	0	0
COLIFORM, FECAL	per 100 mL geo. mean	31616	3	0	0	0	0	0	0	0	0	0	0	0
STREP, FECAL	per 100 mL	31679	0	-	-	-	2	-	-	-	-	-	-	-
FUNGI	per mL	31856	3	1	1	1	1	2	1	1	2	2	0	1
ACTINOMYCETES	per mL	80148	3	1	0	1	0	1	1	0	1	0	0	1
PLANKTON	per mL	60050	3	1033	1200	660	500	780	390	563	2030	60	1093	683

Table 10. (Continued) **SWPP RADIAL LAKE SURVEY SUMMARY TABLE (cont'd.)** - 1987

PARAMETER		STORET NUMBER	SUR-VEYS	ANNUAL MEAN										
				1I	3I	5I	7I	1J	2J	3J	4J	5J	6J	7J
TURBIDITY	N.T.U.	00076	3	0.97	0.67	0.67	0.57	0.72	1.00	0.70	0.75	0.72	0.75	0.68
ODOR, THRESHOLD	T.O.N.	00086	3	1	1	1	1	1	1	1	1	1	1	1
CONDUCTIVITY	µmhos	00095	3	283	282	283	282	283	283	280	282	283	282	282
OXYGEN DEMAND, CHEMICAL	mg/L	00335	3	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
pH		00400	3	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
RESIDUE, TOTAL NONFILTRABLE	mg/L	00530	3	3	2	2	2	0	2	1	1	2	1	1
NITROGEN, ORGANIC	mg/L	00605	3	0.16	0.18	0.17	0.17	0.19	0.15	0.18	0.20	0.16	0.16	0.17
NITROGEN, AMMONIA	mg/L	00610	3	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NITROGEN, NITRITE - NITRATE	mg/L	00630	3	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.24	0.23	0.23
PHOSPHATE, TOTAL	mg/L	00650	3	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01
PHOSPHATE, DISSOLVED	mg/L	00653	3	0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CHLORIDE	mg/L	00940	3	9.4	9.2	9.1	9.0	9.2	9.3	9.2	9.4	9.3	9.3	9.3
SULFATE	mg/L	00945	3	23.3	23.4	23.5	23.1	23.7	23.6	23.8	24.1	23.9	23.0	23.2
PHENOL LIKE SUBSTANCES	µg/L	32730	3	1	1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1
IRON	µg/L	01045	3	34	22	16	18	24	33	19	21	18	18	< 10
PLATE COUNT, 48 HR. - 35°C	per mL	31753	3	82	30	58	6	49	105	197	498	315	254	27
COLIFORM TOTAL	per 100mL	31503	3	5	1	1	0	3	3	3	3	3	6	4
COLIFORM, FECAL	per 100 mL geo. mean	31616	3	2	0	1	0	1	1	0	0	0	1	0
STREP, FECAL	per 100mL	31679	3	-	-	-	-	1	0	0	0	0	0	0
FUNGI	per mL	31856	3	1	2	0	1	1	1	1	2	1	1	1
ACTINOMYCETES	per mL	80148	3	1	1	0	0	1	1	1	0	0	1	1
PLANKTON	per mL	60050	3	813	550	1320	380	2203	-	1000	-	1350	-	1050

Table 11. SWPP ALL STATION WATER QUALITY SUMMARY - 1987

PARAMETER	STORET NUMBER	STANDARD	NO. OF SAMPLES	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	PERCENT VIOLATION
TURBIDITY N.T.U.	00076		66	0.50	1.50	0.76	0.19	-
ODOR, THRESHOLD T.O.N.	00086		66	1	2	1	0.2	-
CONDUCTIVITY µmhos	00095		66	270	295	283	6.5	-
OXYGEN DEMAND, CHEMICAL mg/L	00335		66	< 5	10.1	5.1	0.7	-
pH	00400	7.0-9.0	66	8.4	8.6	8.5	0.1	0
RESIDUE, TOTAL NONFILTRABLE mg/L	00530		66	0	8	2	1.8	-
NITROGEN, ORGANIC mg/L	00605		66	0.12	0.26	0.16	0.03	-
NITROGEN, AMMONIA mg/L	00610	0.02	66	< 0.01	0.20	0.02	0.03	12
NITROGEN, NITRITE-NITRATE mg/L	00630		66	0.18	0.27	0.22	0.02	-
PHOSPHATE, TOTAL mg/L	00650	0.021	66	< 0.01	0.07	0.01	0.01	11
PHOSPHATE, DISSOLVED mg/L	00653		66	< 0.01	0.03	0.01	0.01	-
CHLORIDE mg/L	00940	12.0	66	8.5	10.0	9.2	0.3	0
SULFATE mg/L	00945	24.0	66	19.1	26.1	23.3	2.2	61
PHENOL LIKE SUBSTANCES µg/L	32730	1.0 (b)	36	< 1	5	1	1	11
IRON µg/L	01045	1000 (a)	66	10	60	22	11	-
PLATE COUNT, 48 hr.-35°C per mL	31753		66	0	1300	84	194	-
COLIFORM, TOTAL per 100 mL	31503		66	0	10	3	3	-
COLIFORM, FECAL per 100 mL geo. mean	31616	20 (c)	66	0	6	0	1	0
STREP, FECAL per 100 mL	31679		21	0	2	0	0.6	-
FUNGI per mL	31856		66	0	4	1	0.9	-
ACTINOMYCETES per mL	80148		66	0	2	1	0.6	-
PLANKTON per mL	60050		54	0	5500	925	1164	-

City of Chicago Water Purification Division Water Quality Surveillance Section

(a) General Use Standard (IPCB, 1982)
(b) Public and Food Processing Water Supply Standard (IPCB, 1982)
(c) Geometric Mean

The all station annual arithmetic mean for total coliform was three organism per 100 mL in 1987. Station averages ranged from 0 to 6 organisms/100 mL. The 66 individual samples had relatively low values, ranging from a minimum concentration of zero to a maximum of ten organisms per 100 mL. There is no water quality standard for total coliform concentrations.

Fecal coliform geometric means were zero at 17 of the 22 stations (77%), the remaining five stations averaged 1 or 2 organisms per 100 mL for the year (Table 10). The highest sample value for fecal coliform was 6/100 mL at station 2J on September 29, 1987 (Table 11). The standard for fecal coliform is 20 organisms/100 mL.

The 1987 all station mean for ammonia nitrogen was 0.02 mg/L (Table 11). The ammonia nitrogen mean concentrations at each of the SWPP Radial stations ranged from 0.01 mg/L, at 15 of the 22 locations, to 0.09 mg/L at station 1F (Table 10). Sixty-six samples were collected in 1987 ranging from <0.01 to 0.20 mg/L with 12% exceeding the 0.02 mg/L water quality standard.

Total phosphate samples in 1987 ranged from <0.01 to 0.07 mg/L, with an annual mean of 0.01 mg/L. Station averages ranged from 0.01 to 0.03 mg/L with two stations (1F and 1J) in excess of the 0.021 mg/L water quality standard for total phosphate (Table 10 and Figure 6). Eleven percent of the samples exceeded the water quality standard.

Annual station averages for chloride listed on Table 10 ranged from 8.9 to 9.5 mg/L, with an all station average of 9.2 mg/L. None of the individual samples, ranging from 8.5 to 10.0, exceeded the 12.0 mg/L chloride standard (Table 11).

In 1987 the all station annual mean for sulfate was 23.3 mg/L (Table 11). Station averages for sulfate ranged from 22.1 to 24.1 mg/L. Station 4J had an annual mean value exceeding the 24.0 mg/L water quality standard for sulfate (Table 10 and Figure 6). Individual sample values ranged from 19.1 to 26.1 mg/L with 61% in violation of the sulfate standard.

PHYTOPLANKTON MONTHLY VARIATION, 1986

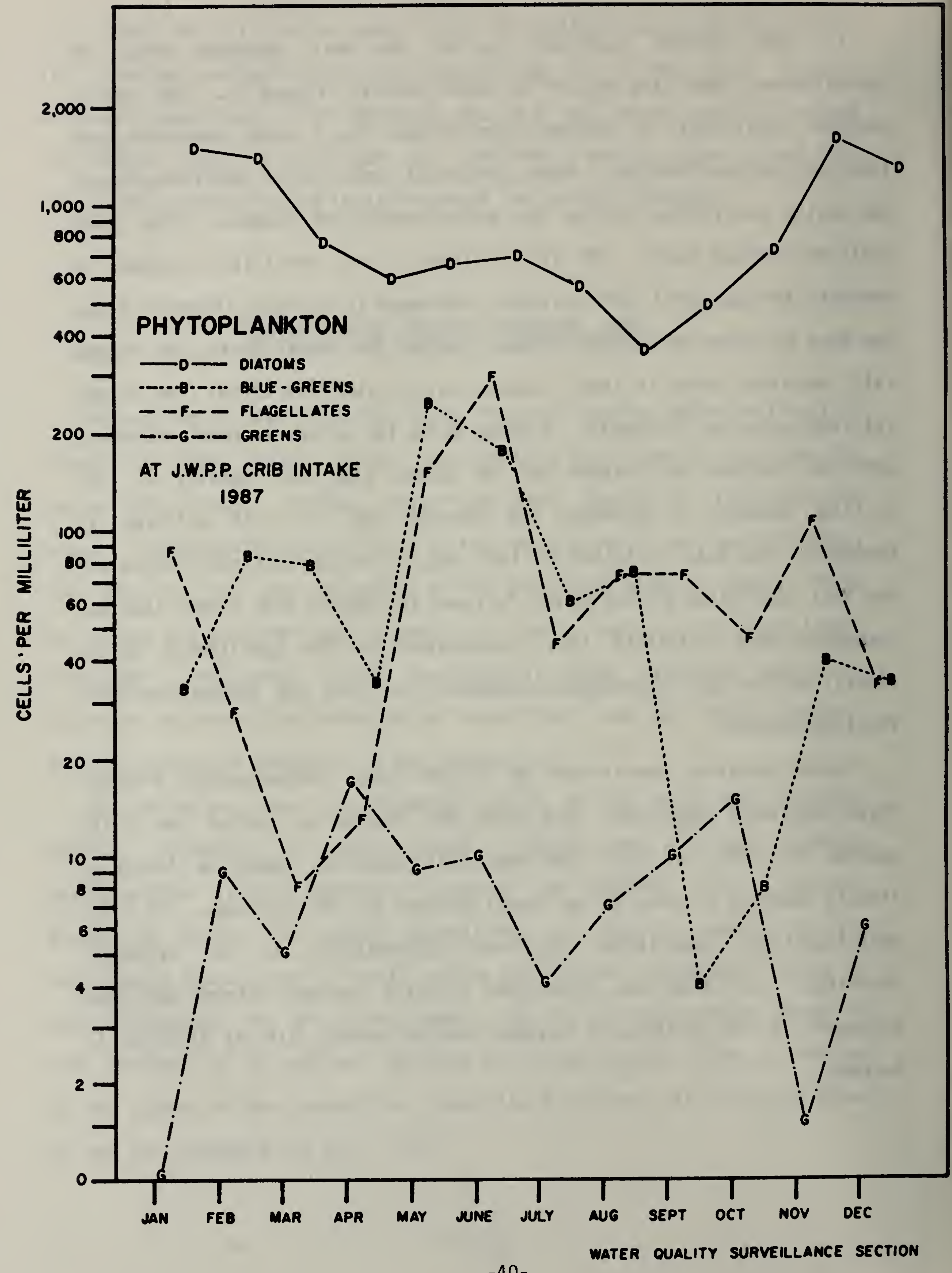
Phytoplankton data collected daily from the Jardine Water Purification Plant crib intake (Figure 1) were divided into four general groupings for evaluation purposes: diatoms, phytoflagellates, blue-green algae and green algae. Phytoplankton composition varies qualitatively and quantitatively from lake to lake and seasonally within any given body of water. These variations are dependent upon a number of abiotic factors: including light, temperature, dissolved solids (particularly those dissolved solids or nutrients necessary for phytoplankton production), and upon biotic factors, such as population adaptability and competition.

Lake Michigan lies in a temperate region of the world that produces various assemblages of phytoplankton. Diatoms are the most abundant phytoplankters in Lake Michigan (Tarapchak and Stoemer, 1978). Seasonal blooms or pulses in diatom populations may occur, usually as two conspicuous blooms, one in early spring and another in autumn. Three or more blooms per year are often common. One factor that creates change in Lake Michigan is the seasonal turnover during spring and autumn as defined by the nature of the thermocline (temperature barriers) at different times of the year (Whipple and Fair, 1933).

In 1987 diatoms continued to be the most dominant group of phytoplankton comprising 84% of the total density (Figure 7). This year's seasonal variations for diatoms were typical for a large temperate zone lake such as Lake Michigan. These variations consisted of considerable but decreasing populations during the winter months of December, 1986 (1370 cells/mL) through March, 1987 (757 cells/mL). Cell densities continued to decrease through April (573 cells/mL) and began to increase slightly in May and June following the spring turnover. During the summer months the diatom cell densities were at their lowest levels, with the annual low of 357 cells/mL occurring in August. October marks the autumn seasonal turnover, with an increase in diatoms and the annual high cell density of 1551 cells/mL peaking in November and tapering off to 1274 cells/mL in December. The data collected in 1987 and as in previous years reiterate the fact that major diatom pulses followed the spring and autumn seasonal turnovers when nutrients that accumulated in the hypolimnion during stratification were distributed throughout the lake and became available for algae growth.

Phytoflagellates constituted 8% of the total phytoplankton density. Phytoflagellates densities were high but decreasing during the first quarter of 1987. By April and May their densities began to increase, finally peaking in June at an annual maximum of 289 cells/mL. In July, phytoflagellate populations declined substantially to 44 cells/mL. Thereafter cell densities fluctuated slightly through October and then increased to 106 cells/mL in November before ending with 33 cells/mL in December.

Figure 7. **Monthly summary of phytoplankton data collected at the crib intake of the Jardine Water Purification Plant**



Blue-green algae typically exhibit a spring pulse and a late summer pulse in large temperate zone lakes. Blue-green algae in Lake Michigan in 1987 constituted 7% of phytoplankton density, making it the third largest group. January densities were 33 cells/mL, concentrations increased to around 80 cells/mL in February and March and decreased to 34 cells/mL in April. Blue-green algae populations increased sharply in May to an annual high of 239 cells/mL and slowly decreased throughout the summer months to an annual low of 4 cells/mL in September. The numbers remained relatively low for the remainder of the year ending in December at 34 cells/mL. Similar to diatoms, the major population peaks of blue-green algae occurred following the spring and fall turnover periods when nutrient availability was greatest. From the data obtained in 1987, it appears the spring turnover occurred in May and the fall turnover in November.

Green algae occur in small-scale pulses during the summer months, some simultaneously with blooms of blue-green algae and diatoms. For the southwestern portion of Lake Michigan during 1987, the green algae occurred in low concentrations (1%), with monthly averages ranging from 1 to 17 cells/mL. The highest levels occurred during April and October with 17 and 15 cells/mL, respectively. These highest levels of green algae may indicate the early stages in nutrient availability of the May and November lake turnovers.

SECTION B

WATER QUALITY TREND ANALYSIS

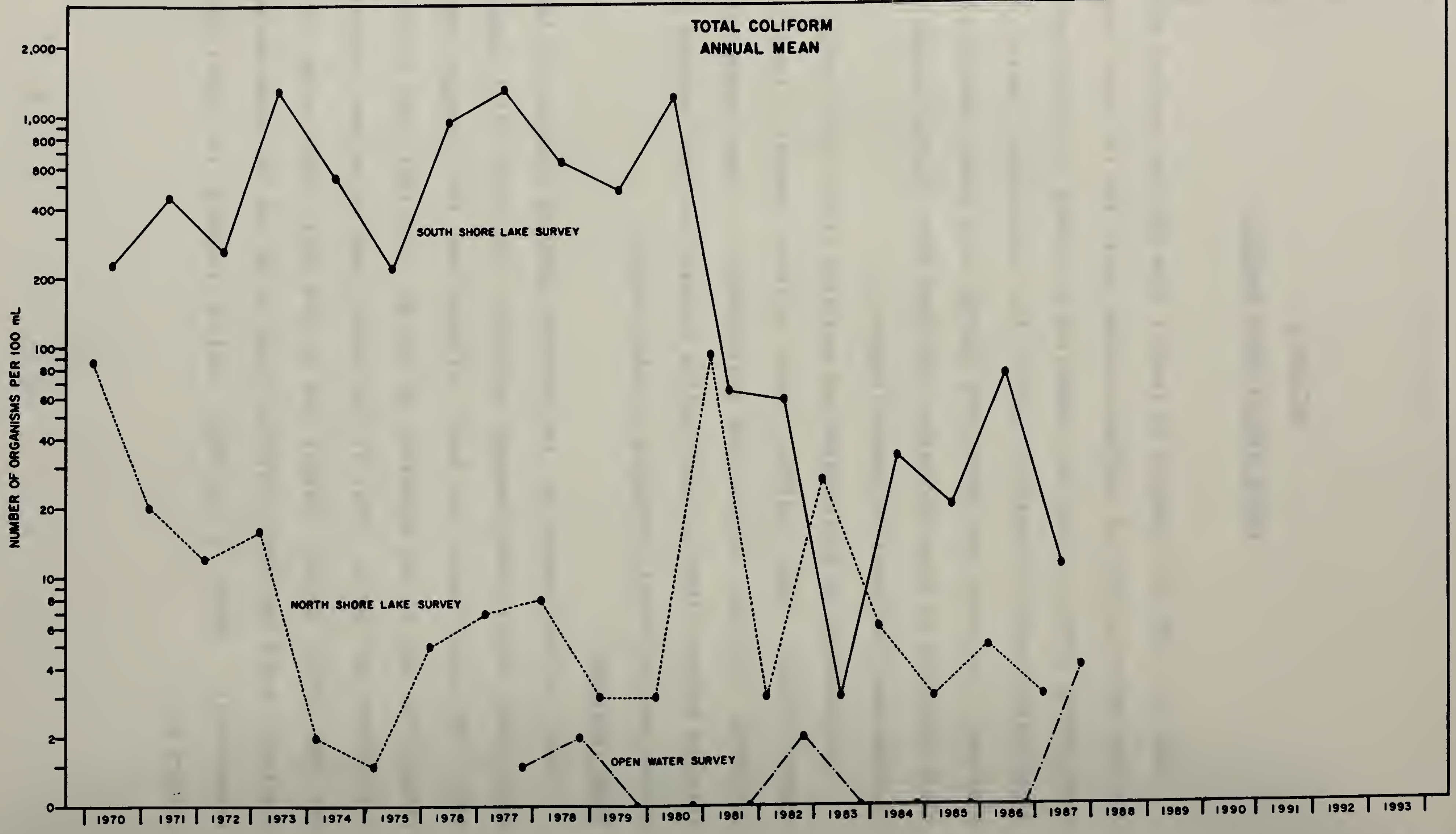
Data for 1987 was compared to results from the ten previous years for the Open Water Survey and eighteen previous years for the North Shore and South Shore Surveys. Data was summarized by survey to better understand local water quality conditions within the southwestern basin of Lake Michigan. The North and South Shore Surveys were chosen because of their close proximity to shore discharges; the Open Water Survey because of its coverage away from shore influences (Figure 1).

The parameters to be discussed and evaluated within this section of the report include: total coliform, fecal coliform, ammonia nitrogen, total phosphate, chloride, sulfate and phytoplankton. These parameters were selected because either a water quality standard has been assigned to them and/or they are direct indicators of water quality.

TOTAL COLIFORM

Total coliform counts for the fourteen sampling stations on the Open Water Lake Survey have remained relatively low since first sampled in 1977. The annual means for total coliform from 1977 through 1986 have ranged from zero to two organisms per 100 mL. The 1987 total coliform was 4 organisms per 100 mL. This is the highest mean value ever recorded for the Open Water Survey, largely due to the April 29th survey in which stations 1 and 2 had total coliform values of 80 and 140 ogranisms/100 mL, respectively. There is no water quality standard for total coliform (Figure 8).

Figure 8. Total coliform trends in Lake Michigan, 1970-1987



WATER QUALITY SURVEILLANCE SECTION

Since 1970, the total coliform annual means on the North Shore Lake Surveys have ranged from 1 to 91/100 mL, with 50% less than 6/100 mL. The 1987 data for North Shore Lake Surveys show continued low total coliform levels with a mean of 3/100 mL.

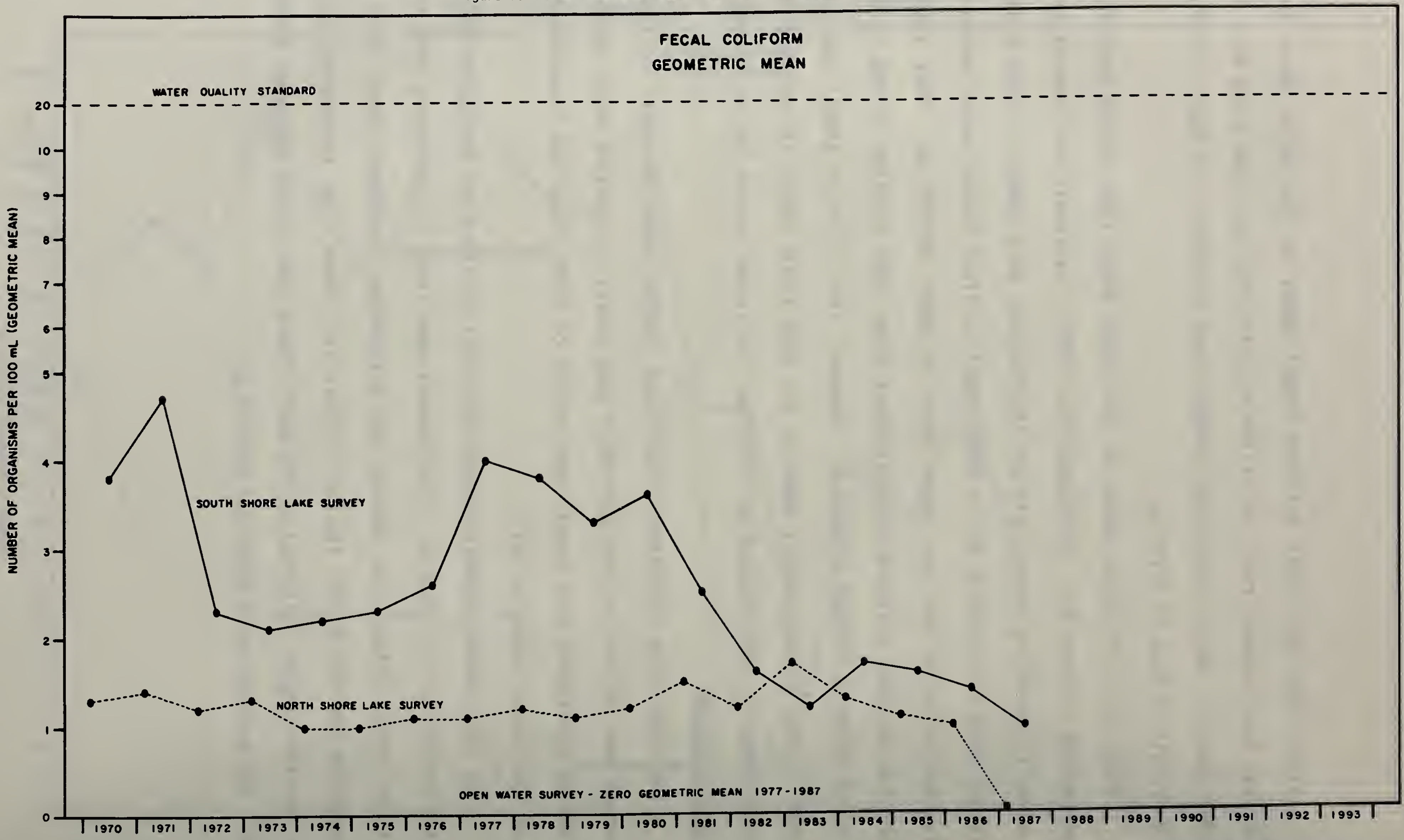
Total coliform annual means on the South Shore Lake Survey have been decreasing (Figure 8). Throughout the 1970's, extremely high annual mean values (fluctuating between 218 and 1293/100 mL) were common. After a near record high of 1198/100 mL in 1980, total coliform annual means decreased substantially for the last seven years to under 100/100 mL. This steady decline in total coliform concentrations since 1980 resulted in the record low of 3/100 mL in 1983 (Figure 8). However, the 75/100 mL annual mean for 1986 is the highest annual mean on the SSLS since 1980. In contrast the annual mean in 1987 dropped to 11/100 mL, the second record low since 1970.

FECAL COLIFORM

The 1987 data indicates a continued stable trend in fecal coliform annual mean values for the Open Water Lake Survey. Excellent water quality remains consistent with annual mean values of zero since the inception of the Open Water Survey in 1977.

The 1987 annual geometric mean for fecal coliform on the North Shore Lake Survey was < 1/100 mL. This annual mean level is consistent with the stable trend established during the preceeding seventeen years of < 2 organisms per 100 mL for the NSLS (Figure 9). Since 1978, two percent (13) of the 669 samples collected on the North Shore Lake Survey exceeded 20/100 mL. The maximum value found was 102/100 mL.

Figure 9. **Fecal coliform trends in Lake Michigan, 1970-1987**



WATER QUALITY SURVEILLANCE SECTION

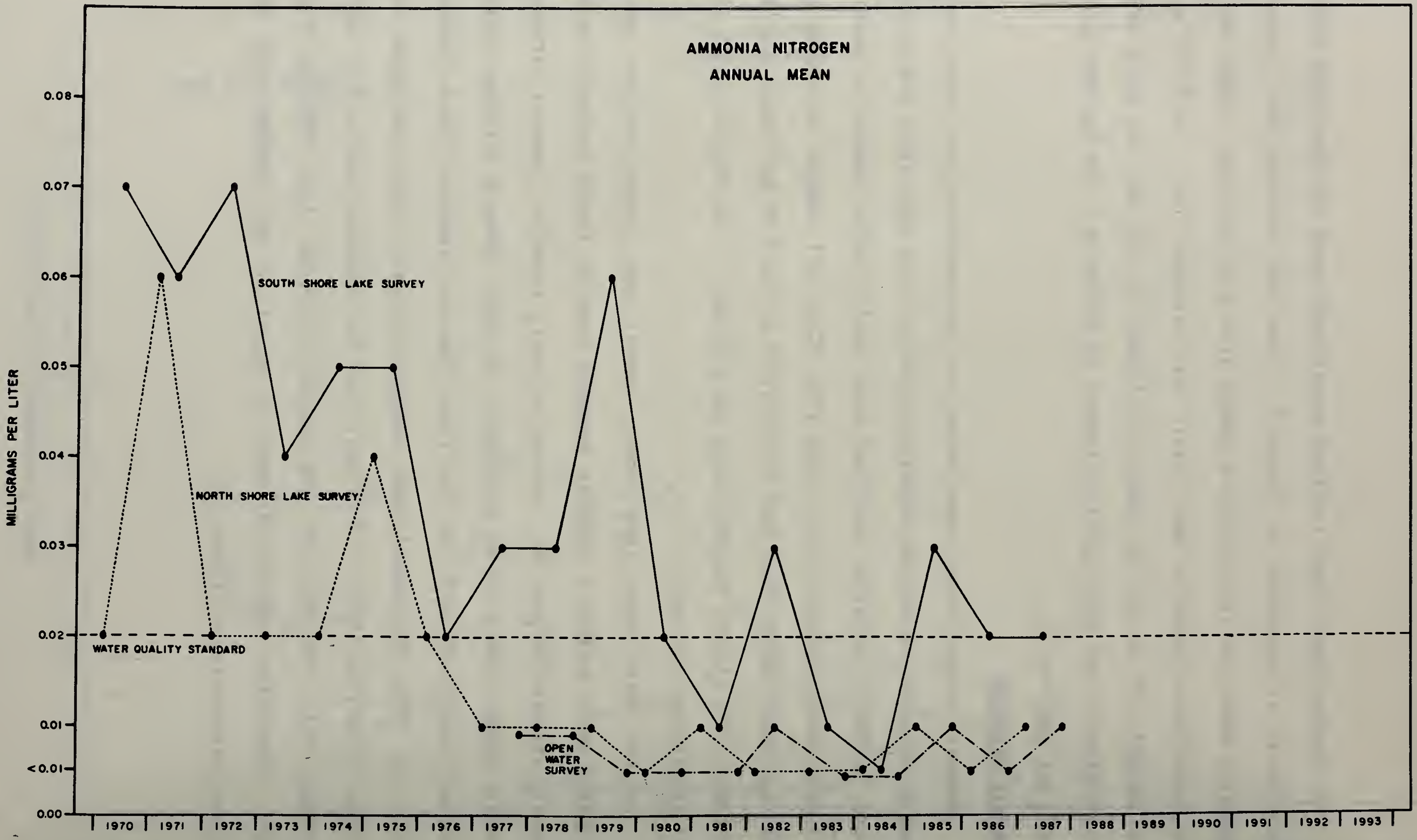
An eighteen year fecal coliform annual mean graph for the South Shore Lake Survey is presented in Figure 9. From 1970 through 1981, annual geometric means for fecal coliform ranged from 2 to 5/100 mL. Since 1981, the South Shore geometric mean levels have averaged from 1 to 2/100 mL. Ten percent (74) of the 752 samples collected for the last ten years were in violation of the water quality standard of 20/100 mL. The maximum value found was 6800/100 mL.

AMMONIA NITROGEN

Ammonia nitrogen annual mean values for the Open Water Lake Survey have been at or below the minimum detectable limit of 0.01 mg/L since the survey began in 1977, indicating excellent water quality with regards to ammonia nitrogen content (Figure 10). Since 1978, 2% of 571 samples collected on the Open Water Survey have been in violation of the 0.02 mg/L water quality standard. The highest recorded value was 0.20 mg/L. The mean value of all 571 samples was 0.01 mg/L.

On the North Shore Lake Survey, annual mean values for the past eighteen years exhibit a definite downward trend to levels below the water quality standard (Figure 10). During the early seventies, ammonia nitrogen levels ranged from 0.02 to 0.06 mg/L. In 1976, ammonia nitrogen levels dropped below 0.02 mg/L for the first time and remained there through 1978. In 1979, the annual mean continued to drop, this time below the minimal detection limit of 0.01 mg/L, and has remained nearly 0.01 mg/L through 1987. The mean for 670 samples collected since 1978 was 0.01 mg/L. Twenty-two samples (3%) were in excess of the standard with the highest value being 0.30 mg/L.

Figure 10. **Ammonia nitrogen trends in Lake Michigan, 1970-1987**



WATER QUALITY SURVEILLANCE SECTION

South Shore ammonia nitrogen annual mean values have decreased since 1970 (Figure 10). Although the trend was downward, mean values were still in excess of the 0.02 mg/L water quality standard during this time. In 1981, the annual mean was below the minimum detectable limit of 0.01 mg/L for the first time since 1970. Annual mean levels from 1980 to 1987 have ranged from <0.01 to 0.03 mg/L. This represents a definite improvement in water quality along the south shore since the 1970's. The mean value for 752 samples collected since 1978 was 0.03 mg/L. One hundred thirty-four samples (18%) were in excess of the standard with concentrations ranging from 0.03 to 1.50 mg/L.

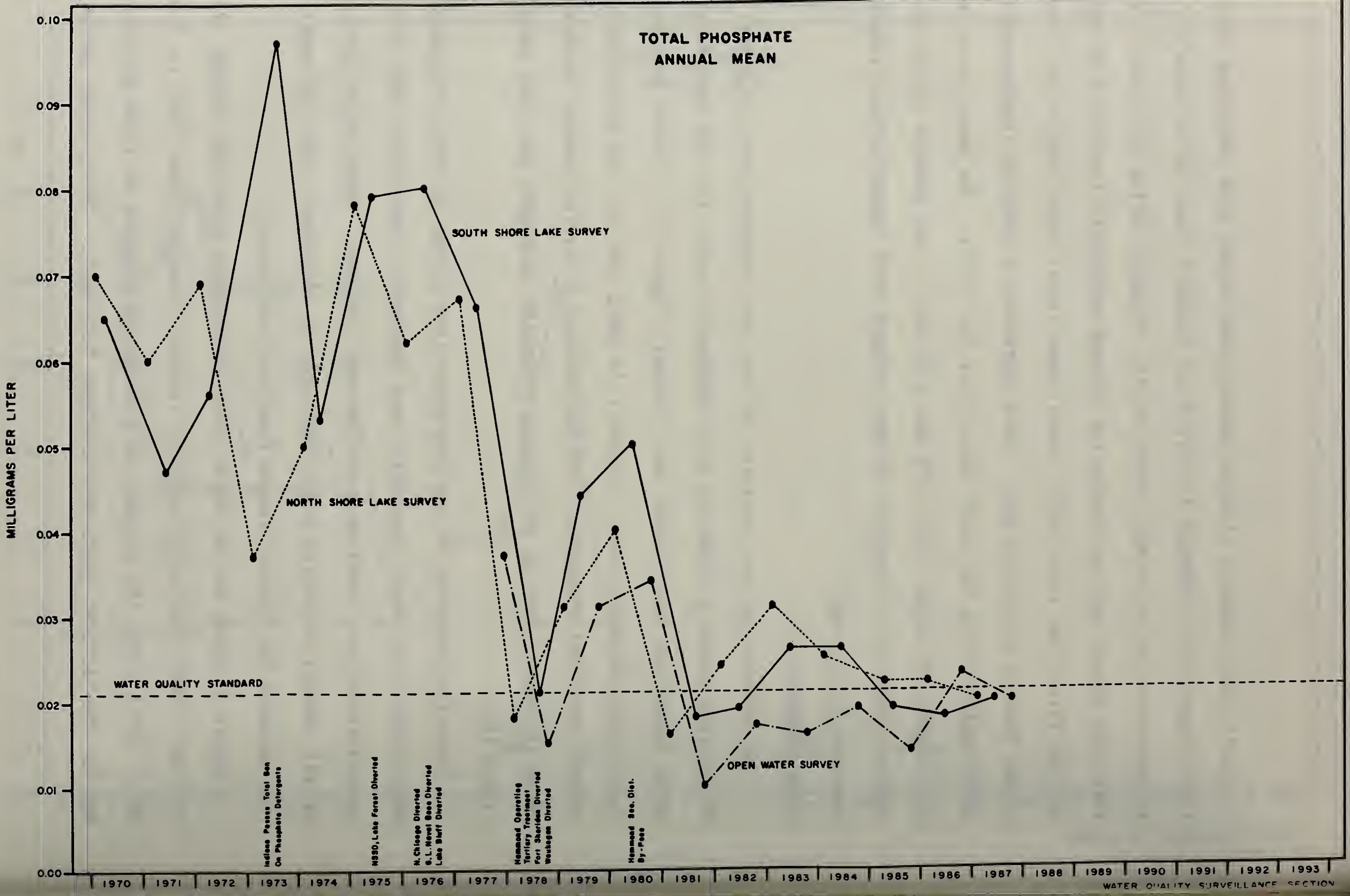
TOTAL PHOSPHATE

The annual mean plot analysis of the last eighteen years indicates a fluctuating downward trend in total phosphate levels for the Open Water, North Shore and South Shore Lake Surveys (Figure 11). Total phosphate levels have decreased over the years in part due to: the diversion of several municipal discharges, the operation of a tertiary sewage treatment plant in Hammond and by the Indiana phosphate detergent ban (see margin Figure 11).

Since the inception of the Open Water Lake Survey in 1977, the annual mean values for total phosphate have decreased, and since 1981 these concentrations have remained below the IPCB standard. Twenty-eight percent of all samples collected since 1978 were in violation. The 158 samples that exceeded the standard ranged from 0.03 to 0.24 mg/L.

Annual averages on the North Shore Lake Survey from 1970 through 1977 were well above the water quality standard, ranging from 0.04 to 0.08 mg/L. Since 1978, the averages were below the standard on three occasions and for the last ten years have averaged 0.03 mg/L. Thirty-seven percent

Figure 11. Total phosphate trends in Lake Michigan, 1970-1987



of 670 North Shore Survey samples collected from 1978 through 1987 were in violation of the standard. The maximum concentration was 0.11 mg/L.

The South Shore Lake Survey annual averages from 1970 to 1977 ranged from 0.05 to 0.10 mg/L. Since 1977 total phosphate levels have decreased dramatically, with the exception of 1979 and 1980, to levels near the IPCB standard. High levels of total phosphate found in 1980 on the South Shore Survey were the result of a Hammond Sanitary District by-pass that year (Figure 11). Forty-four percent (331) of the 752 samples collected since 1978 were in violation of the water quality standard. The highest maximum total phosphate value during this time was 0.21 mg/L. The mean of these 331 samples in violation was 0.05 mg/L.

CHLORIDE

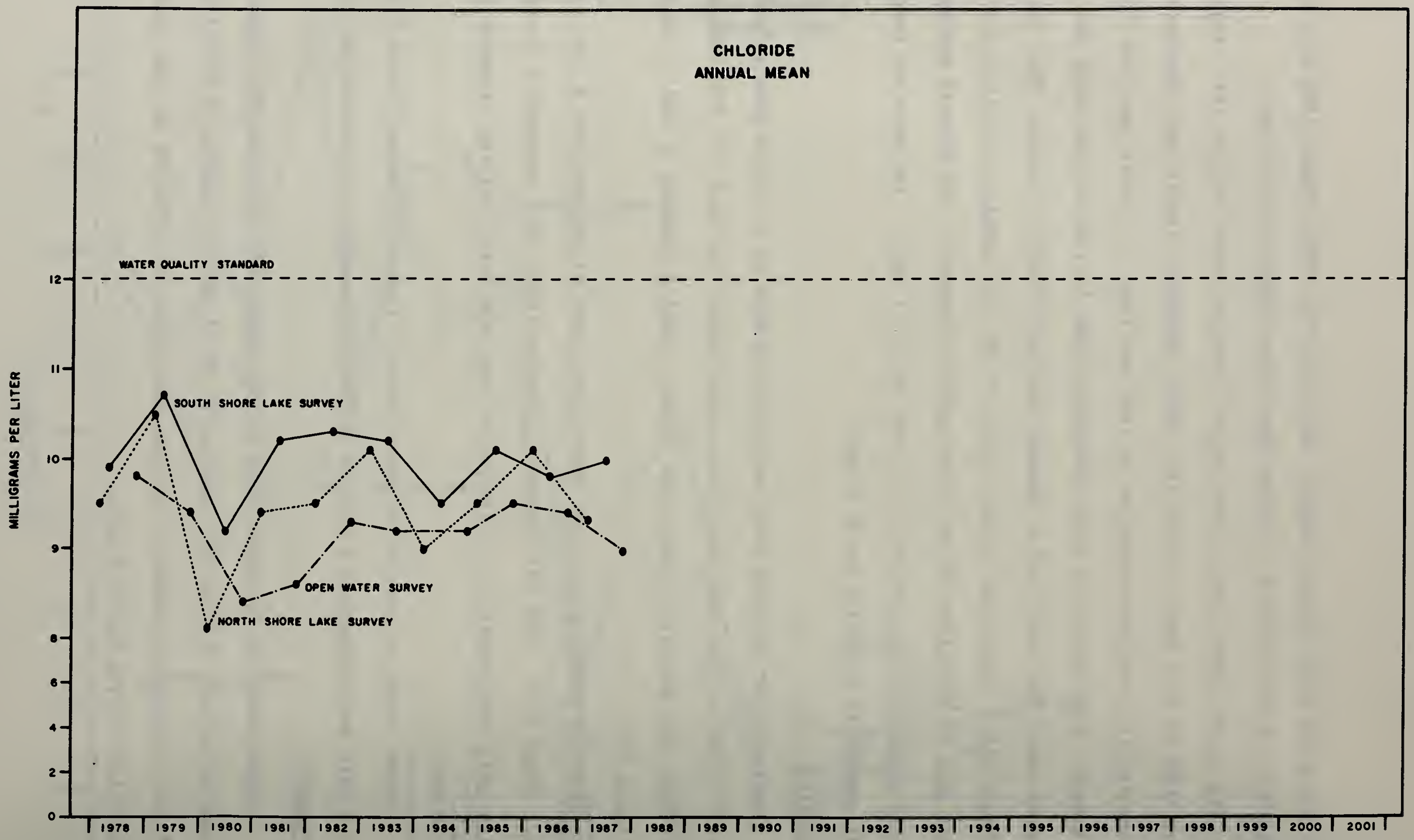
Analyses for chloride were not routinely made on all three lake surveys until 1978. Since that time the annual means for each of the surveys indicate no definite trend with values ranging between 8 and 11 mg/L (Figure 12).

Chloride means on the Open Water Survey have fluctuated from 8.4 to 9.8 mg/L since 1978. The 571 samples collected since 1978 averaged 9.2 mg/L with only one sample in violation of the IPCB water quality standard of 12.0 mg/L.

Annual means on the North Shore Survey since 1978 ranged from 8.1 to 10.5 mg/L and averaged 9.4 with 2% of the 670 samples in violation of the standard.

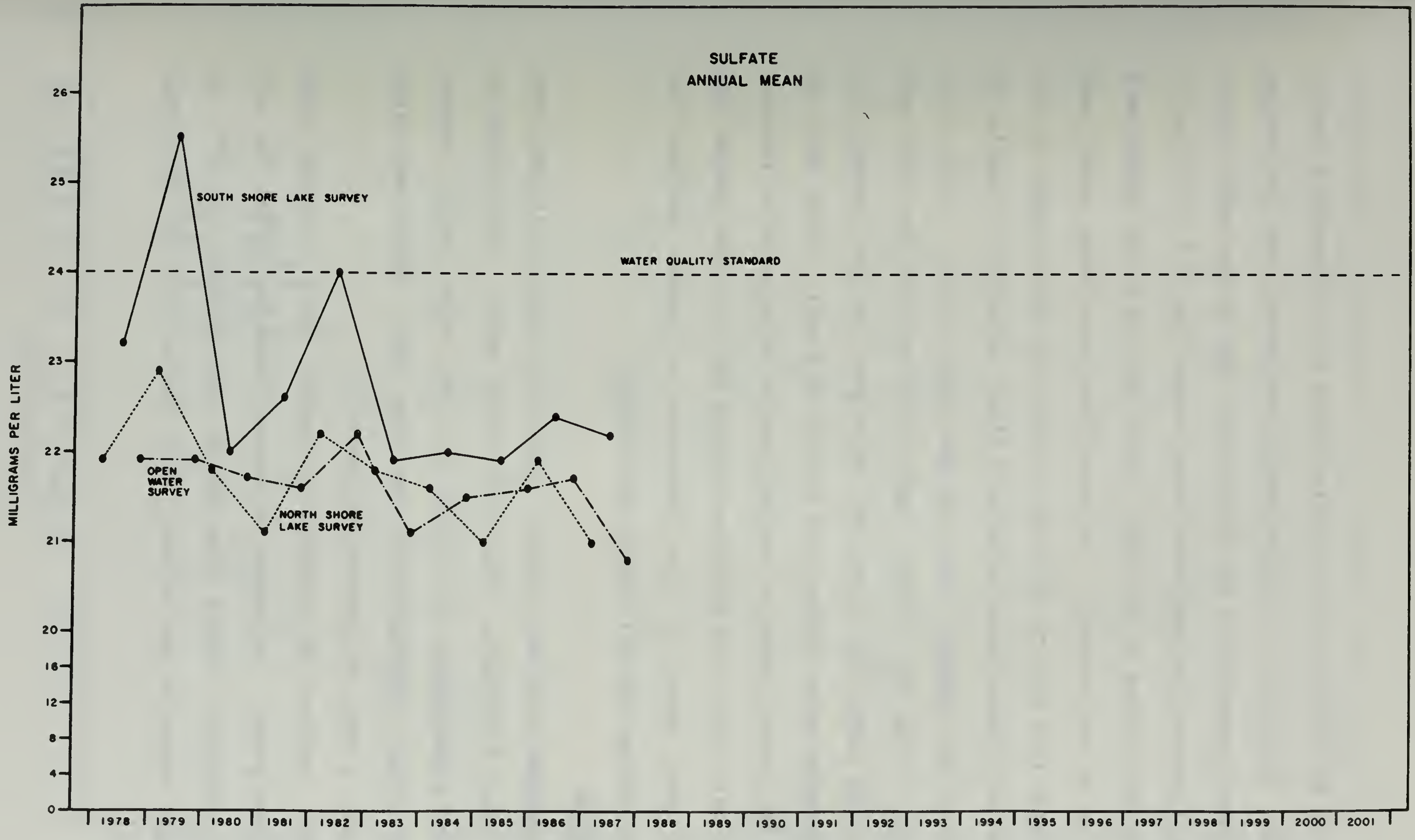
Annual means on the South Shore Survey since 1978 exhibited the highest range of values, 9.2 to 10.7 mg/L, with 4% of the 752 samples in violation of the 12.0 mg/L standard. The ten year mean for chloride on the South Shore Lake Survey was 10.0 mg/L.

Figure 12. **Chloride trends in Lake Michigan, 1978-1987**



WATER QUALITY SURVEILLANCE SECTION

Figure 13. **Sulfate trends in Lake Michigan, 1978-1987**



SULFATE

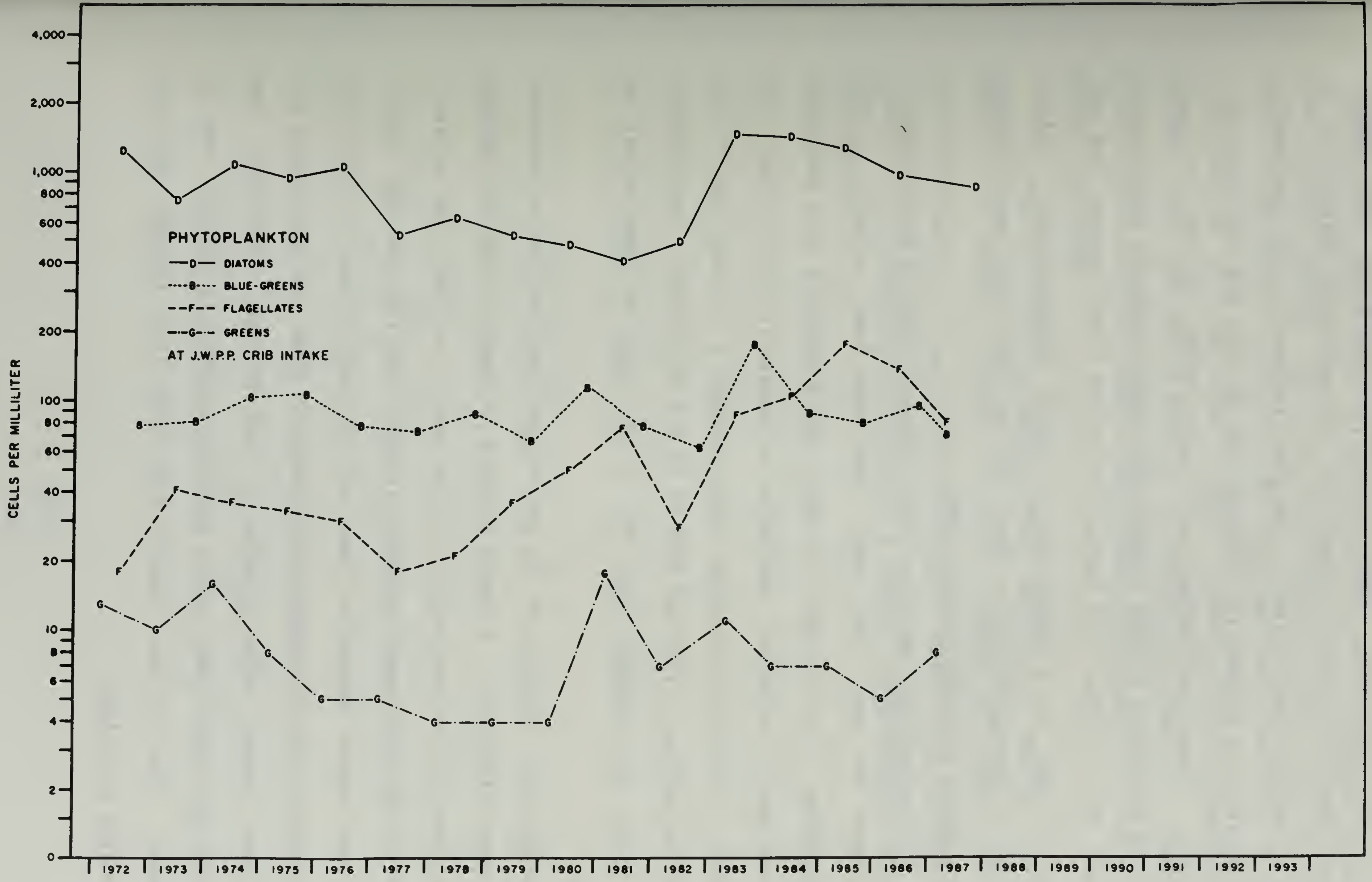
Analyses for sulfate were not routinely made for all three lake surveys until 1978. Fluctuations in sulfate annual mean values from 1978 through 1986 were more pronounced on the shore surveys than on open water (Figure 13). Annual means on the Open Water Survey ranged from 20.8 to 22.2 mg/L, with a ten year average of 21.7 mg/L. Since 1978, 3% of the samples were in violation of the standard. The North Shore Lake Survey annual mean values ranged from 21.0 to 22.9 mg/L, with a ten year average of 21.7 mg/L. The North Shore Survey exhibited a higher percentage of samples in violation of the standard than the Open Water Survey. Since 1978, forty-eight of the 669 sulfate samples (7%) exceeded the 24.0 mg/L standard. The South Shore Survey had the highest ten year average, 22.8 mg/L, with annual means ranging from 21.9 to 25.5 mg/L. Since 1978, 123 (16%) of 752 sulfate samples on the SSLS were in violation of the standard, more than twice that of the North Shore Survey and five times greater than the Open Water Survey; a clear indication of greater municipal and industrial loading into this area of Lake Michigan.

PHYTOPLANKTON

Phytoplankton data was obtained from daily samples collected from Jardine Water Purification Plant Crib Intake water. For purposes of discussion, phytoplankton are divided into four major groups: diatoms, blue-green algae, phytoflagellates, and green algae. Annual mean values for the past 16 years are presented in Figure 14.

Diatoms continue to dominate in number over the other three phytoplankton groups. The numbers of diatoms fluctuated during the early seventies (1972-76), ranging from 758 to 1221 cells/mL. In 1977, the annual mean dropped to 520 cells/mL, less than half of the 1974 annual

Figure 14. **Phytoplankton trends in Lake Michigan, 1972-1987**



WATER QUALITY SURVEILLANCE SECTION

average of 1074 cells/mL. After a slight increase in 1978, diatom populations began to steadily decrease for the next three years to a 16 year low of 400 cells/mL in 1981. A marginal increase in 1982 preceeded a dramatic increase in diatoms for 1983 and 1984 to 1484 and 1443 cells/mL, respectively. These mean values were record highs for this 16 year period. The mean value in 1985 through 1987 slowly decreased each year to the present 851 cells/mL. The decrease in diatom levels between 1968 and 1982 may be due to a reduction in silica concentrations. Silica concentrations decreased rapidly after 1954 to levels that were limiting for diatom growth by 1968 (Schelske, 1985).

The blue-green algae were the second largest group of phytoplankton. However, over the past four years they have been replaced by the phytoflagellates. For the past 16 years the blue-greens have exhibited only slight yearly variations, indicating an apparently stable trend. The mean value in 1983 for blue-green algae reached a 15 hear high of 178 cells/mL, decreasing in 1984 and 1985 to 88 and 80 cells/mL, respectively. Recent values are averaging near the 16 year mean of approximately 90 cells/mL.

A sixteen year analysis of the phytoflagellates indicates an apparent upward trend (Figure 14). A steady increase in numbers from 1977 through 1985 resulted in a 16 year high of 179 cells/mL. The 1986 (138 cells/mL) and 1987 (80 cells/mL) means decreased slightly from 1984 and 1985 levels. This is the fourth consecutive year (of the last sixteen) in which the phytoflagellates have out-numbered the blue-green algae and have become the second most abundant alga grouping in Lake Michigan. Previously the phytoflagellates annual mean values equaled approximately one half that of blue-greens. The 16 year annual mean from 1972 through 1987 was approximately 61 cells/mL.

Since 1972, green algae cell concentrations were generally stable, with annual averages ranging from 4 to 18 cells/mL and comprising the smallest density algae group. The green algae decreased from 16 cells/mL in 1974 to a 16 year low of 4 cells/mL in 1978. Annual averages remained at 4 cells/mL until 1981 when a high of 18 cells/mL was observed. Green algae concentrations have decreased slightly and are presently at the 16 year mean of 8 cells/mL.

The factors affecting phytoplankton variations, whether short-term (seasonal or annual) or long-term (over a number of years), and their inter-relationships are not fully understood. Further data collection and research are necessary to develop a better understanding of these relationships.

SECTION C

TROPHIC STATE EVALUATION

The trophic state of a lake refers to the rate of primary biological production it is capable of supporting. Traditionally, lakes classified by trophic status have been placed into three broad categories.

1. Oligotrophic lakes have low concentrations of nutrients such as phosphorus and nitrogen and support little plant growth. Biological productivity is generally low, and the waters are clear.
2. Mesotrophic lakes are intermediate in character between oligotrophic and eutrophic. They are moderately well supplied with nutrients and generally support moderate biological productivity.
3. Eutrophic lakes are nutrient rich and generally highly productive, capable of supporting a large amount of plant growth and other biological activity. Eutrophic lakes cover a myriad of water quality conditions, ranging from very desirable recreational lakes that support excellent warm water fisheries, to lakes with undesirable aesthetics and water use limitations.

The eutrophication process is classically defined in terms of natural glacial lakes. Glaciated lakes normally begin as oligotrophic bodies of water with stable water quality and long natural successional lives. Increases in productivity of their waters are generally brought about by increasing nutrient concentrations.

Lescht and Rockwell (1985) presented three systems to characterize the trophic status of the Great Lakes based on total phosphorus, chlorophyll a and Secchi depth. The system developed by Rast and Lee (1978) is presented in Table 12.

Table 12. Trophic status classifications based on Rast and Lee (1978)

Parameter	Oligotrophic	Mesotrophic	Eutrophic
Total Phosphorus (ug/L)[1]	< 10	10-20	> 20
Chlorophyll a (ug/L)	< 2	2-6	> 6
Secchi depth (meters)	> 4.6	4.6-2.7	< 2.7

1) Total phosphorus x 3.067 = total phosphate

Total phosphorus (equivalent to total phosphate/3.067) is the only one of these parameters which is routinely monitored by the City of Chicago. (Figure 11). Ninety percent of North Shore, 73% of South Shore and 100% of Open Water Stations were classified as oligotrophic in 1987. Remaining stations (1N, 1S, 3S, 5S) were classified as mesotrophic. This is a major improvement over what was found during the 1970s, when only 11% of North and South Shore stations were classified as oligotrophic, 39% as eutrophic and 50% as mesotrophic (Figure 15). This improvement was due to diversion of north shore municipal effluents away from Lake Michigan, tertiary treatment at Hammond Sanitary District and an Indiana ban of phosphate detergents.

Chlorophyll a samples were collected at selected JWPP and SWPP radial survey stations in May and September, 1987 (Table 13). Concentrations ranged from 1.35 ug/L to 3.89 ug/L with a mean (± SD) of 2.36 (±0.78) ug/L.

Figure 15. Trophic status of Lake Michigan 1970 - 1979 and 1980 - 1987. (Based on total phosphate annual means for each North and South Shore station)

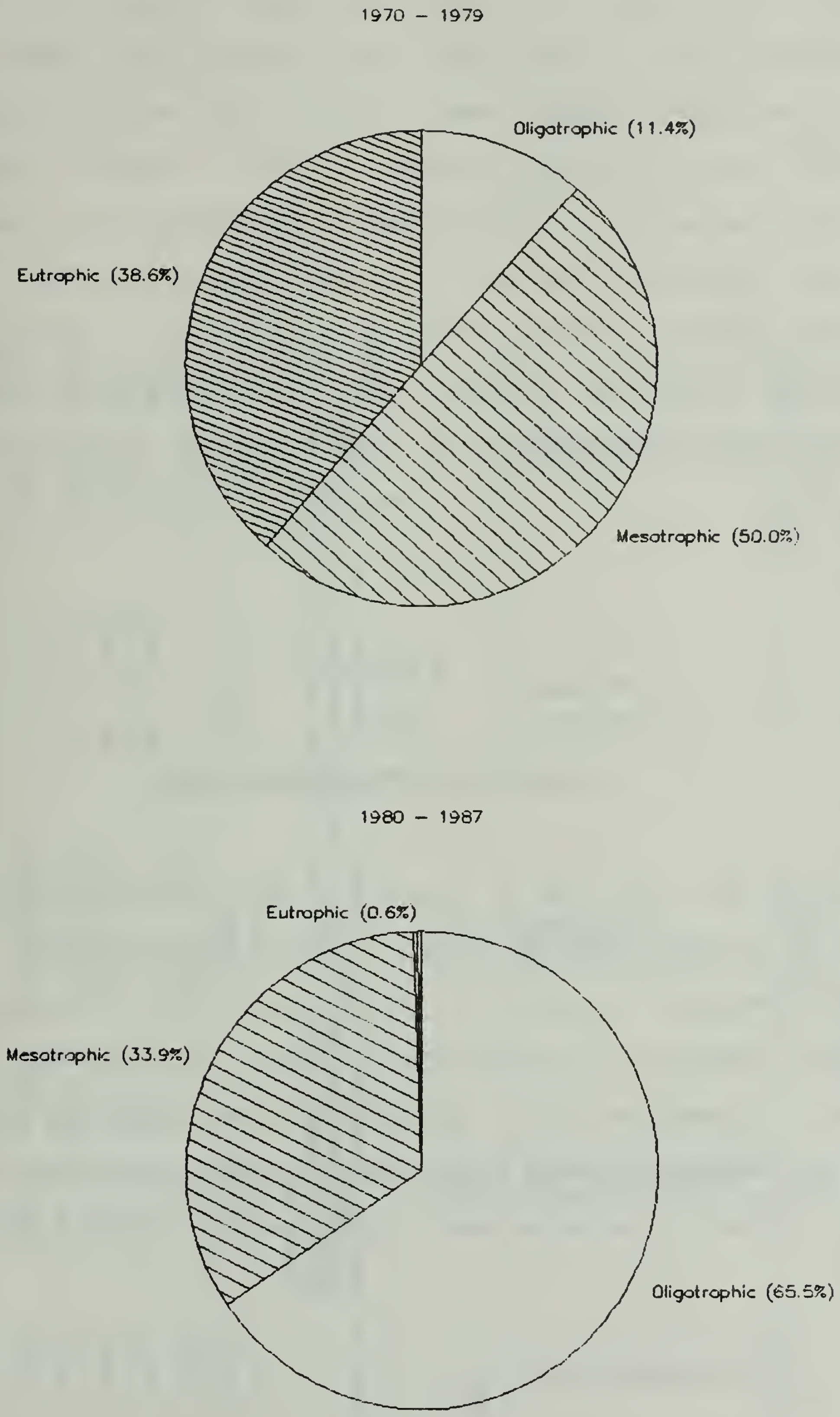


Table 13. Lake Michigan chlorophyll "a" concentrations (ug/L) at six JWPP stations on May 13 and at six SWPP stations on May 27 and September 29, 1987.

Stations	May	September	Mean	Standard Deviation
5A	2.14	--	--	--
5B	1.87	--	--	--
1C	1.87	--	--	--
5C	1.89	--	--	--
5D	1.55	--	--	--
4E	1.35	--	--	--
3F	2.20	2.75	2.48	0.39
5G	1.67	3.89	2.78	1.57
5H	2.04	2.14	2.09	0.07
5I	2.27	1.65	1.96	0.44
2J	3.89	3.34	3.62	0.39
5J	3.32	2.67	3.00	0.46
Mean	2.17	2.74		
SD	0.73	0.80		

Table 14. Mean (±standard deviation) chlorophyll "a" concentrations (ug/L) at 12 JWPP and SWPP Lake Michigan stations in spring, summer and fall 1982 - 1987. Number of samples are in parenthesis. Samples were collected at a depth of three feet.

Year	Spring	Summer	Fall	Total
1982	--	2.32 ± 1.03(9)	--	2.32 ± 1.09(9)
1983	8.22 ± 2.10(5)	--	5.28 ± 1.76(6)	6.61 ± 2.39(11)
1984	4.17 ± 1.63(12)	1.05 ± 0.31(6)	1.09 ± 2.18(6)	2.62 ± 2.20(24)
1985	3.24 ± 0.76(6)	0.83(1)	3.83 ± 0.94(6)	3.32 ± 1.12(13)
1986	3.04 ± 1.10(12)	1.16 ± 0.48(12)	--	2.10 ± 1.27(24)
1987	2.17 ± 0.73(12)	--	2.74 ± 0.80(6)	2.36 ± 0.78(18)
Total	3.68 ± 2.13(47)	1.50 ± 0.88(28)	3.23 ± 2.12(24)	2.96 ± 2.07(99)

Chlorophyll a samples have been collected at these 12 stations since 1982 (Table 14). There have been differences in number of samples, numbers of stations and sampling seasons over these six years. As a result, comparison between years cannot be made. Over these six years, the highest concentrations have been found in spring, when the peak phytoplankton bloom usually occurs (Figure 7), and the lowest concentrations were found in summer. Mean (± SD) chlorophyll a concentrations by season were: 3.68 (± 2.13) ug/L, 1.50 (± 0.88) ug/L and 3.23 (± 2.12) ug/L for spring, summer and fall, respectively. The mean (±SD) for all 99 samples collected from 1982 through 1987 was 2.96 (±2.07) ug/L indicating mesotrophic conditions. However, since most of the samples were collected in spring (47%), this may not accurately reflect overall conditions.

SECTION D

TOXICS

AND FISH CONSUMPTION ADVISORIES

Toxics monitoring consisted of analysis of water and fish samples for pesticides, polychlorinated biphenyls (PCB's) and heavy metals. Pesticides and PCB's evaluated in this study belong to a class of compounds known as chlorinated hydrocarbons. Chlorinated hydrocarbons are extremely resistant to biological degradation and are persistent in the environment. In water, chlorinated hydrocarbons become concentrated in aquatic organisms, and these concentrations increase exponentially in those organisms at the top of the food chain.

While most heavy metals and trace elements occur naturally in the environment, extensive use of metals in industry often results in concentrations greatly exceeding natural levels. Certain heavy metals are known to be highly toxic to aquatic organisms and are cumulative in the food chain (Hesse and Evans 1972). The pesticides and metals evaluated are described in the glossary (Appendix III).

WATER

Monitoring for pesticides and metals began in 1979. Three stations are monitored; station 5A on the Jardine Water Purification Plant (JWPP) radial survey and stations 5H and 5J on the South Water Purification Plant (SWPP) radial survey. In addition to these stations, metals and cyanide are collected at nine other stations: JWPP 5B, 1C, 5C, 5D, 4E and SWPP 3F, 5G, 5I, 2J (Figure 1). Each station is scheduled to be sampled twice per year in spring and fall. However, due to the limited number of surveys run each year, weather conditions and tug availability, this has not always been possible.

Water samples for pesticide and PCBs analysis were collected at station 5A on May 13 and at stations 5H and 5J on September 29, 1987. Dieldrin and total chlordane were the only organochlorine compounds detected. Dieldrin was detected at all three stations with concentrations of 0.001 ug/L to 0.002 ug/L. Total chlordane was detected at stations 5H to 5J with a concentration of 0.003 ug/L. This is the first time since 1981 that pentachlorophenol was not detected in any samples.

Table 15. Detectable concentrations of pentachlorophenol, dieldrin and total chlordane in Lake Michigan water samples, 1979-1987*.

Parameter	Date	Station	Concentration (ug/L)
Pentachlorophenol (0.001 ug/L) **	9/8/82	5A	0.140
	9/8/82	5H	0.072
	9/8/82	5J	0.074
	5/17/83	5A	0.005
	5/30/84	5A	0.004
	5/14/85	5H	0.015
	5/14/85	5J	0.017
	8/27/85	5A	0.004
	5/6/86	5J	0.004
	7/8/86	5A	0.004
Dieldrin (0.001 ug/L) ** (1.0 ug/L) ***	5/17/83	5A	0.001
	5/30/84	5A	0.001
	5/13/87	5A	0.002
	5/29/87	5H	0.001
	5/29/87	5J	0.001
Total Chlordane (0.002 ug/L) ** (3.0 ug/L) ***	5/17/83	5A	0.002
	9/29/87	5H	0.003
	9/29/87	5J	0.003

* Total of 39 samples for dieldrin and chlordane, 27 samples for pentachlorophenol.

** Detection Limit

*** Public and Food Processing Water Supply Standard.

Table 16. Summary of total metals, cyanide, fluoride and hardness concentrations at six JWPP and six SWPP Lake Michigan stations, 1987.

Parameters	Standard	No. of Samples	No. below Detection Limit	Minimum	Maximum	Mean	Standard Deviation	Percent Violation
Cyanide (mg/L)	0.025(a)	18	18	<0.005	<0.005	<0.005	0	0
Fluoride (mg/L)	1.40(c)	6	0	0.14	0.18	0.16	0.01	0
Calcium (mg/L)	-	18	0	35	38	36	1	-
Magnesium (mg/L)	-	18	0	11	15	13	2	-
Hardness * (mg/L)	-	18	0	130	153	143	8	-
Potassium (mg/L)	-	18	0	0.30	1.40	0.92	0.35	-
Sodium (mg/L)	-	18	0	4.9	6.0	5.3	0.3	-
Aluminum (ug/L)	-	18	17	<50	57	<50	2	-
Arsenic (ug/L)	50(b)	18	17	<1	3	<1	<1	0
Barium (ug/L)	1000(b)	18	0	14	23	19	3	0
Beryllium (ug/L)	-	18	18	<0.5	<0.5	<0.5	0	-
Boron (ug/L)	1000(c)	18	18	<50	<50	<50	0	0
Cadmium (ug/L)	10(b)	18	18	<3	<3	<3	0	0
Chromium (ug/L)	50(b)	18	11	<5	26	<9	6	0
Cobalt (ug/L)	-	18	16	<5	6	<5	0	-
Copper (ug/L)	20(c)	18	16	<5	6	<5	0	0
Iron (ug/L)	1000(c)	18	14	<50	112	<60	23	0
Lead (ug/L)	50(b)	18	18	<50	<50	<50	0	0
Manganese (ug/L)	150(b)	18	14	<5	13	<6	2	0
Mercury (ug/L)	0.5(c)	17	17	<0.05	<0.05	<0.05	0	0
Nickel (ug/L)	1000(c)	18	11	<5	17	<7	4	0
Silver (ug/L)	5(c)	18	14	<3	8	<3	1	5.5
Strontium (ug/L)	-	18	0	112	122	117	3	-
Vanadium (ug/L)	-	18	18	<5	<5	<5	0	-
Zinc (ug/L)	1000(c)	18	18	<50	<50	<50	0	0

a) Lake Michigan Standard (35 IL Adm. Code 302)
b) Public and Food Processing Water Supply Standard (35 IL Adm. Code 302)
c) General Use Standard (35 IL Adm. Code 302)
* Calculated

Since the beginning of this monitoring in 1979, pentachlorophenol has been detected in 10 of 27 samples (37.0%), dieldrin in 5 of 39 samples (12.8%) and total chlordane in 3 of 39 samples (7.7%) (Table 15). All concentrations of dieldrin and total chlordane were well below Public and Food Processing Water Supply Standards (35 IL Adm. Code 302). There is presently no Illinois water quality standard for pentachlorophenol. However, levels of pentachlorophenol found were well below levels considered toxic to aquatic life and unsafe for public health protection (USEPA, 1986).

Water samples for total metals and cyanide analysis were collected at the six JWPP stations on May 13 and at the six SWPP stations on May 27 and September 29, 1988. Results are presented in Appendices II-1, II-2, II-3 and summarized in Table 16. The General Use Standard for silver (5 ug/L) was exceeded at Station 3F (8 ug/L) on May 27. This was the second violation of this standard out of 111 samples (1.8%) collected since 1981. Both violations were found on the South Radial in a heavily industrialized area. Silver was detected in 8.1% of samples collected since 1981. Detectable levels ranged from 3 to 10 ug/L with a mean (±SD) of 5 (±2) ug/L. Rockwell et al (1980) detected silver in 6 of 104 samples (5.8%) with a maximum concentration of 7 ug/L.

Cyanide, beryllium, boron, cadmium, lead, mercury, vanadium and zinc were not detected in any samples. Remaining parameters had concentrations well within water quality standards and were similar to results found since 1979 (City of Chicago and IEPA, 1987).

Fish Consumption Advisories

Chemical contaminants have been found in some lakes and streams where they accumulate in sediments, aquatic organisms and fish. Consumption of contaminated fish can represent a major source of chemical exposure for humans. Many Lake Michigan fish are contaminated to some extent with PCBs, pesticides or other toxic substances.

In general, fish which contain more toxic chemicals than permitted under current Food and Drug Administration action levels should not be eaten or sold for human consumption. It should be noted that any food containing fat soluble contaminants such as PCB or DDT potentially represents an additional exposure to toxic chemicals which accumulate in the human body, concentrate in breast milk and therefore, represent some degree of risk. Long term risks to health are not well defined at this time. Sport caught fish, even those with low contaminant levels, can represent a major source of exposure if eaten often enough. Women who might breast feed should not make Lake Michigan fish a major part of their regular diet. Eliminating or reducing the frequency of consumption or eating smaller sized fish can also reduce the degree of exposure and accordingly any health risks which may be associated with exposure.

To provide uniform advisories on this subject, health officials from the states of Illinois, Indiana, Michigan and Wisconsin in cooperation with the Environmental Protection Agency's Great Lakes National Program Office have jointly reviewed all available contaminant monitoring data for Lake Michigan sport fish.

Popular sport fish species from Lake Michigan were evaluated on the basis of whether or not these fish comply with the PCB, DDT, Chlordane and Dieldrin action levels established by the U.S. Food and Drug Administration to regulate the commercial sale of fish and shellfish (Table 17).

Table 17. U.S. Food and Drug Administration health standards for contaminants commonly found in sport fish.

PCBs	2 parts per million (ppm)	Chlordane	0.3 ppm
DDT	5 ppm	Dieldrin	0.3 ppm
Toxaphene	5 ppm	Mercury	1.0 ppm

The following advice is provided concerning consumption of Lake Michigan sport fish (Table 18):

Group 1 - Fish with the Lowest Level of Contaminants

Eating Group 1 fish poses the lowest health risk. Contaminant levels in 10 percent or less of fish tested in this group exceed any FDA health standards. Trim fat and skin from these fish before cooking and eating.

Group 2 - Fish with Moderate Levels of Contaminants

Nursing mothers, pregnant women, women who anticipate bearing children, female children of any age and male children age 15 or under should not eat Group 2 fish. All other individuals should limit their consumption of these fish, and trim skin and fat before cooking and eating. Contaminant levels in more than 10 percent but less than 50 percent of fish tested in this group exceeded one or more FDA health standards.

Group 3 - Fish with High Levels of One or More Contaminants

NO ONE should eat Group 3 fish. Contaminant levels in 50 percent or more of fish tested in this group exceeded one or more FDA health standards.

Table 18. Lake Michigan sport fish grouped according to levels of contaminants.[1]

Group 1 (Low)	Group 2 (Moderate)	Group 3 (High)
Lake Trout (less than 20")	Lake Trout (20-23")	Lake Trout (over 23")
Chinook Salmon (less than 21")	Chinook Salmon (21-32")	Chinook Salmon (over 32")
Coho Salmon (less than 26")	Coho Salmon (over 26")	Brown Trout (over 23")
Pink Salmon	Brown Trout (less than 23")	Carp
Rainbow Trout		Catfish
Brook Trout		
Yellow Perch		
Smelt		

[1] Based on the presence of lipid soluble contaminants such as PCB, DDT, Dieldrin, Chlordane and Toxaphene.

Twenty-one composite fish fillets samples, collected from the Illinois area of Lake Michigan in 1987, were analyzed for organochlorine compounds. Chlordane and PCBs were the compounds detected most often and were the only ones to exceed USEPA Actions Levels (Table 19). The Action Level for PCBs (2.0 mg/Kg) was exceeded in three samples (14.3%) including Carp (18.0 mg/Kg), Lake Trout (5.60 mg/Kg) and Chinook Salmon (2.60 mg/Kg). Two samples (9.5%) exceeded the chlordane Action Level (0.30 mg/Kg) and included Carp (0.58 mg/Kg) and Lake Trout (0.58 mg/Kg). All excursions were found in the largest fish collected in 1987.

Figures 16 through 19 compare PCB and chlordane concentrations with mean lengths for trout and salmon collected in 1986 and 1987. Of the ten excursions of USFDA standards, five were found in Lake Trout over 23 inches long, three in Chinook Salmon over 36 inches and two in Brown Trout over 22 inches. The highest PCB concentration of 11.00 mg/Kg was found in Chinook

Table 19. Concentrations of chlordane and polychlorinated biphenyls (PCBs) in fish fillet composite samples from the Illinois area of Lake Michigan, 1987.

Date Collected	Fish Species	No. Fish in Sample	Mean Length (inches)	Mean Weight (pounds)	Percent Fat	Total Chlordane (mg/kg)	Total PCBs (mg/kg)
4/87	Alewife	25	6.9	0.1	4.9	0.05	0.46
10/87	Brown Trout	3	12.1	0.6	3.0	0.07	0.65
9/87	Brown Trout	5	18.9	3.3	7.2	0.14	1.20
9/87	Brown Trout	5	23.0	6.7	6.3	0.14	0.96
9/87	Carp	1	33.8	32.6	28.0	0.58	18.00
9/87	Chinook Salmon	6	22.5	4.7	2.5	0.14	0.88
9/87	Chinook Salmon	5	28.6	9.1	1.4	0.13	0.69
9/87	Chinook Salmon	5	32.8	12.0	1.2	0.17	1.70
9/87	Chinook Salmon	6	36.3	16.4	1.9	0.23	2.60
9/87	Coho Salmon	5	16.3	2.1	1.5	0.06	0.35
9/87	Coho Salmon	5	23.3	4.4	3.7	0.04	0.21
9/87	Coho Salmon	5	25.6	5.6	1.7	0.08	0.25
10/87	Coho Salmon	3	28.0	6.8	1.1	0.07	0.38
8/87	Lake Trout	5	15.8	1.5	5.0	0.09	0.55
8/87	Lake Trout	5	23.7	4.6	12.0	0.19	1.60
8/87	Lake Trout	5	28.7	9.7	19.0	0.58	5.60
10/87	Rainbow Trout	3	11.9	0.8	5.1	0.15	1.00
10/87	Rainbow Trout	7	17.8	2.6	7.9	0.13	1.10
9/87	Rainbow Trout	5	21.8	5.3	7.3	0.14	1.10
10/87	Rainbow Trout	5	26.0	7.6	6.0	0.13	0.64
6/87	Yellow Perch	10	8.9	0.3	0.4	<0.02	<0.10
			USFDA Action Level			0.30	2.00
			Number above action level			2	3
			Percent above action level			9.5	14.3

Figure 16. PCB's in Lake Michigan trout fillets

1986 and 1987.

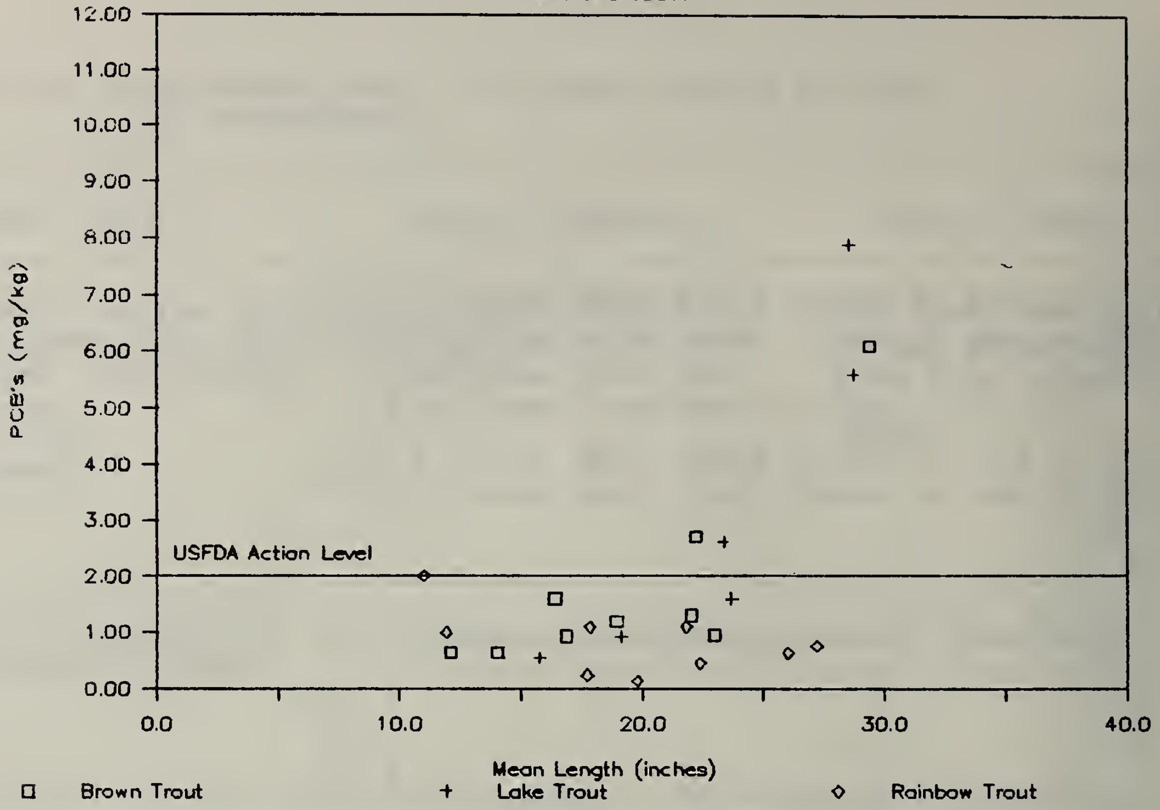


Figure 17. PCB's in Lake Michigan salmon fillets

1986 and 1987.

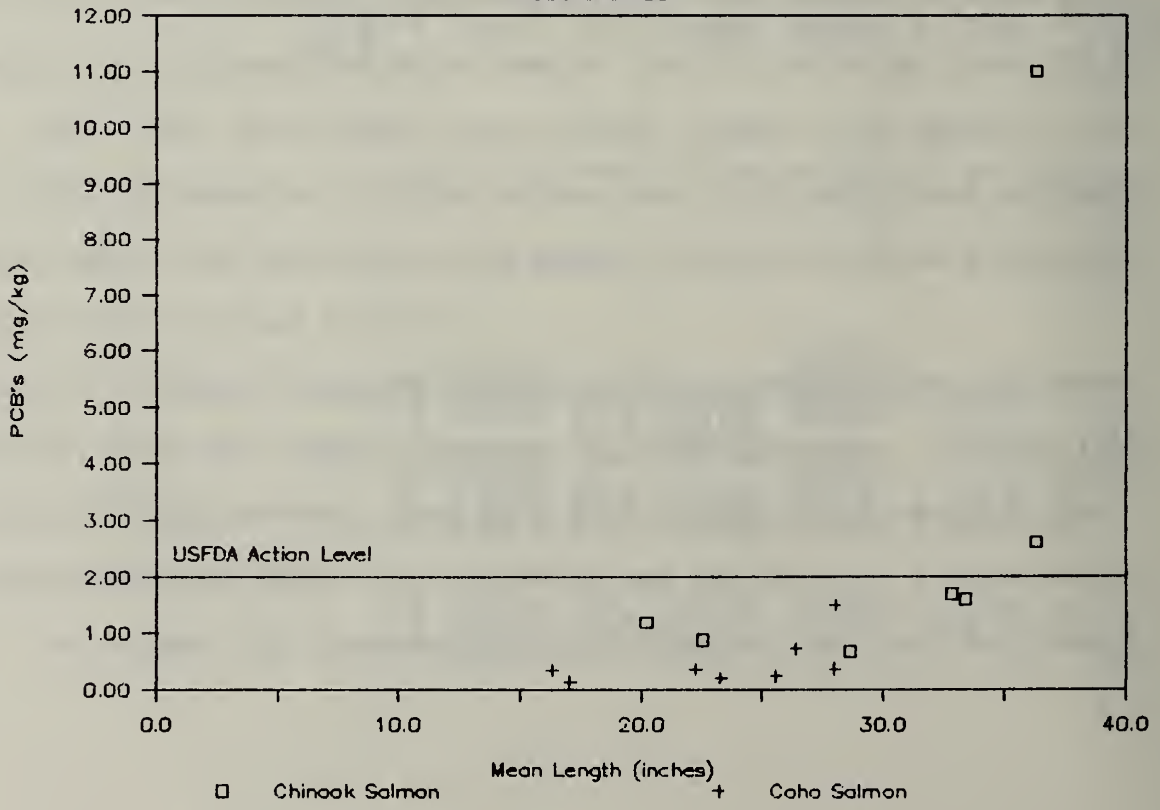


Figure 18. Chlordane in Lake Michigan trout fillets, 1986 and 1987.

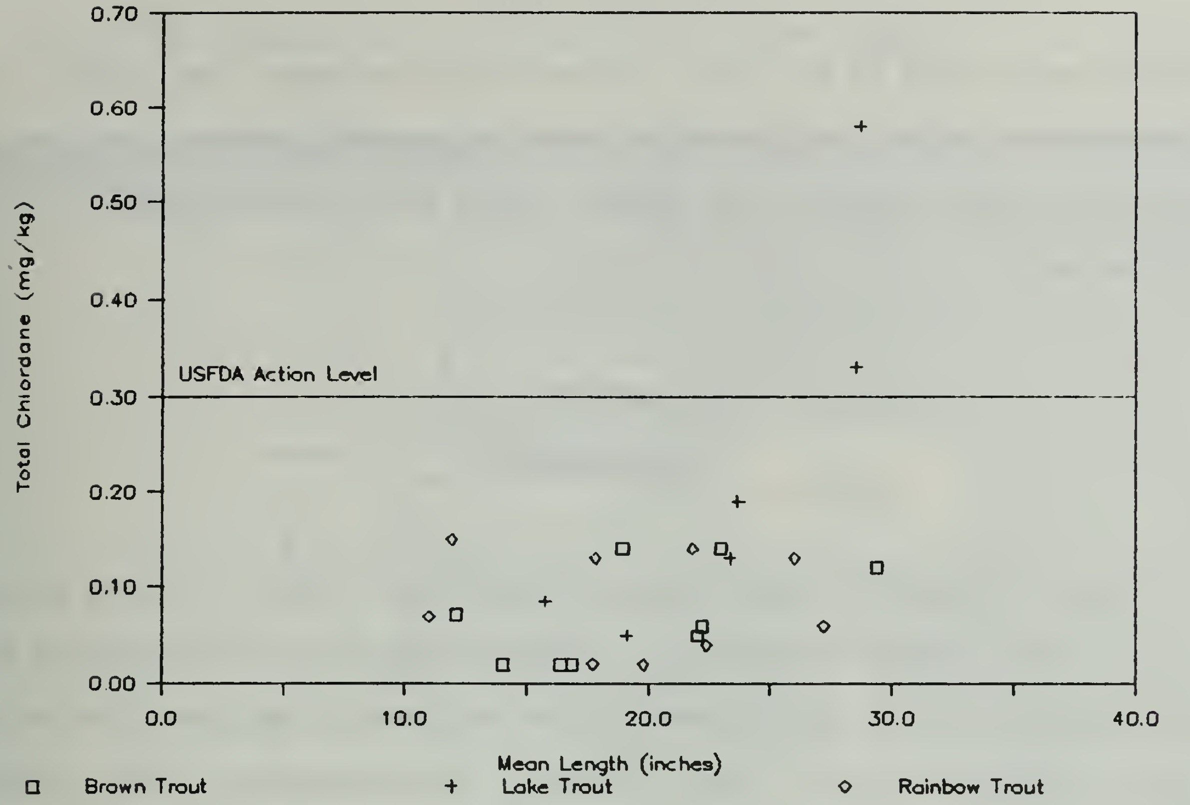
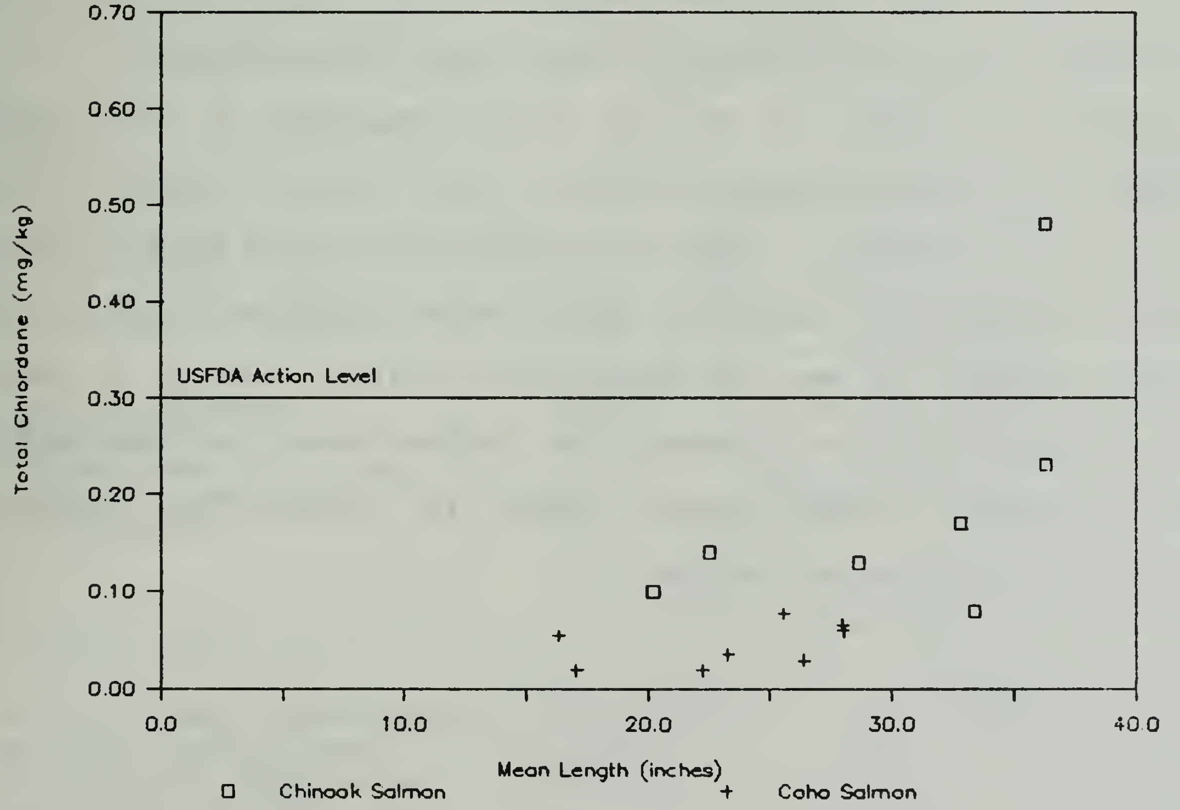


Figure 19. Chlordane in Lake Michigan salmon fillets, 1986 and 1987.



Salmon (mean length 36.3 inches) and the highest chlordane concentration of 0.58 mg/Kg was found in Lake Trout (Mean length 28.7 inches). The lowest levels of these compounds were found in Coho Salmon (mean lengths 16.3 to 28.0 inches).

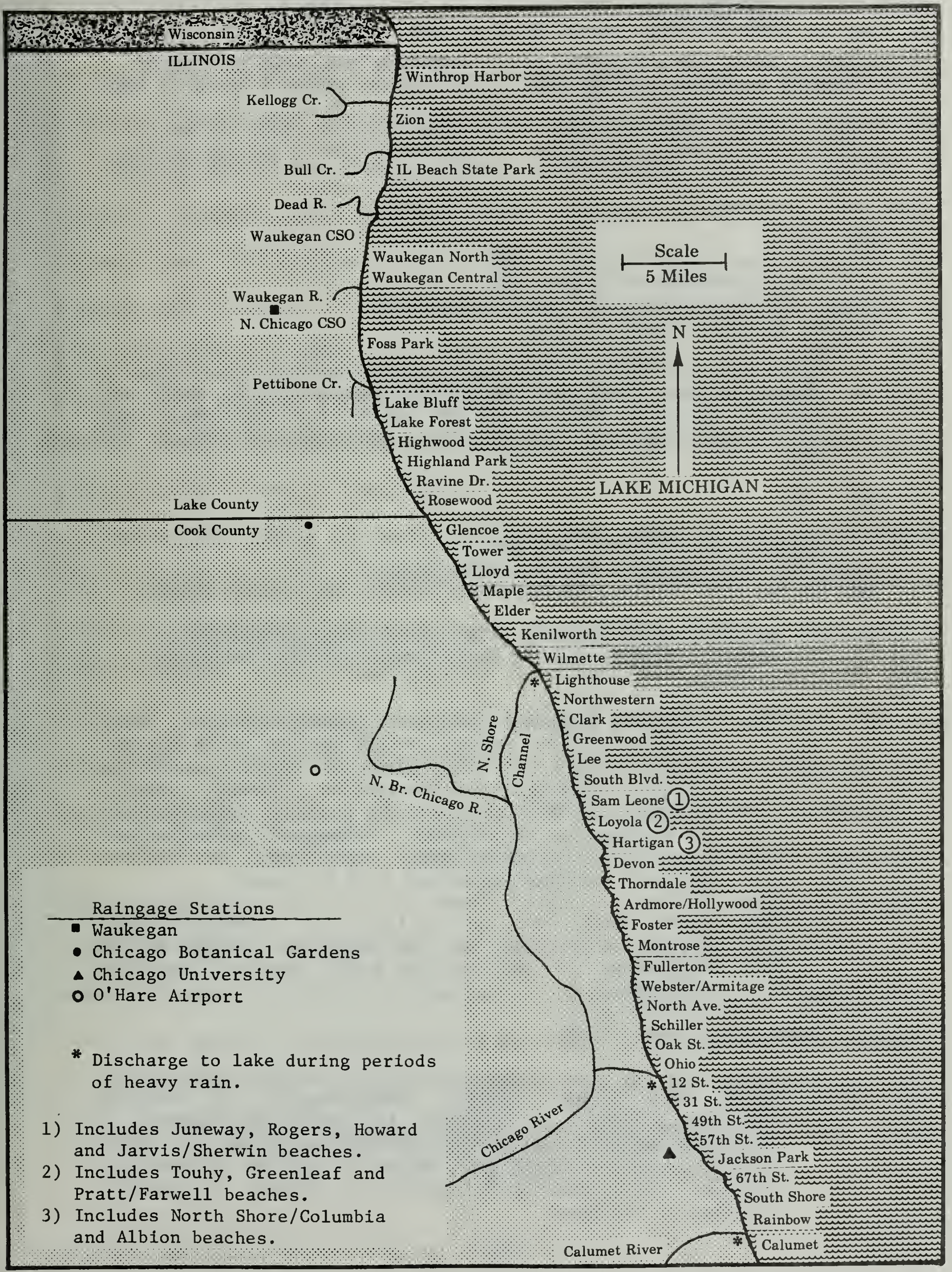
SECTION E

BEACH QUALITY

There are 58 public Lake Michigan beaches in Illinois, 12 in Lake County and 46 in Cook County (Figure 20). Agencies responsible for monitoring the water quality at the beaches are: Lake County Health Department and North Shore Sanitary District (Lake County), Evanston-North Shore Health Department (8 Cook County beaches), Village of Winnetka (4 Cook County beaches), Village of Wilmette (1 Cook County beach) and the Chicago Park District (33 Cook County beaches). Daily fecal coliform samples are collected at each beach during the swimming season (June-September).

Both the Illinois EPA and the Illinois Department of Public Health (IDPH) have swimming standards based on fecal coliform bacteria. These standards are presented in Table 20. Local agencies close beaches in their jurisdiction when two consecutive samples exceed 500/100 mL fecal coliform (IDPH standard), or when the Metropolitan Sanitary District of Greater Chicago (MSDGC) bypasses stormwater and combined sewer overflows to Lake Michigan at the Wilmette Pumping Station, the Chicago River Controlling Works and the O'Brien Lock and Dam.

Figure 20. Locations of Illinois Lake Michigan beaches.



* Discharge to lake during periods of heavy rain.

1) Includes Juneway, Rogers, Howard and Jarvis/Sherwin beaches.
2) Includes Touhy, Greenleaf and Pratt/Farwell beaches.
3) Includes North Shore/Columbia and Albion beaches.

Table 20. Water quality guidelines for beaches based on fecal coliform counts (No./100 ml).

WATER CONDITIONS	
(Good) Full Support	(Poor) Nonsupport
1. Geometric mean ≤200 and 0-10% of samples exceed a count of 400.	Geometric mean >200 or >10% of samples exceed a count of 400.
2. Total coliform ≤5000 and fecal coliform ≤500 in two consecutive samples.	Total coliform >5000 or fecal coliform >500 in two consecutive samples.

1. IEPA, 1987

35 ILLINOIS ADMINISTRATIVE Code 302
Subpart B: General Use Water Quality Standards
Section 302.209 - Fecal Coliform

Based on a minimum of five samples taken over not more than a 30-day period, fecal coliform (STORET number 31616) shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10% of the samples during any 30 day period exceed 400 per 100 ml.

2. IDPH, 1987

77 ILLINOIS ADMINISTRATIVE Code 802
Subpart E: Bathing Beach Design and Operation
Section 820.500 - Minimum Sanitary Requirements for Bathing Beaches

(a) 2) Bacteriological Quality. The bacteriological quality of water at bathing beaches shall comply with the following criteria:

A) Coliform bacteria counts of 1,000 per 100 ml or fecal coliform bacteria counts of 100 per 100 ml in any two samples shall be considered sufficient grounds to require additional investigation, survey, special analyses and correction of any problems determined to be causing the high counts. Subsequent evaluation and satisfactory bacteriological results must be obtained before a construction permit will be issued.

B) There shall be no sanitary or combined sewer discharges or other raw or partially treated sewage discharges to the bathing beach area or immediate watershed.

(e) Bathing Beach Operation

2) Water Quality. During operation, the facility shall comply with the water quality requirements of Section 820.500(a)(2)(A). In addition to these requirements, a coliform bacteria count of over 5,000 per 100 ml or a fecal coliform count over 500 per 100 ml in any two consecutive samples shall constitute sufficient grounds to require closing of the beach.

A total of 4,486 fecal coliform samples were collected at 51 beaches from June through September 10, 1987. Winthrop Harbor, Foss Park and Devon beaches were closed in 1987 due to high water levels. Results were not received from the Winnetka Park District for Tower, Lloyd, Elder and Maple beaches. Results for the 51 beaches are summarized in Table 21 and Figure 21. None of the beaches had a geometric mean greater than the 200/100 mL standard. However, fecal coliform counts in excess of 400/100 mL were found in more than 10% of the samples from Highland Park beach (23.7%) and Waukegan North beach (12.9%). Consecutive samples greater than 500/100 mL occurred 21 times in 1987; nine times at Highland Park, three times at Park Avenue, twice at Ohio Street and once each at Zion, Waukegan North, Waukegan Central, Lake Bluff, Highwood, Rosewood and Schiller beaches. Most of the excursions were found in Lake County.

The highest levels of fecal coliform were found in August, following heavy rainfall and severe flooding (Figure 22). A total of 12.84 inches of rain fell from August 13 through August 16 at O'Hare Airport. As a result, MSDGC bypassed 971 million gallons of storm water and combined sewer overflows from the Wilmette Pumping Station and 986 million gallons from the Chicago River Controlling Works into Lake Michigan on August 14th and 15th. The North Shore Sanitary District's (NSSD) Waukegan plant discharged 74 million gallons of combined sewer overflows into Lake Michigan from August 14th through the 19th and the North Chicago plant discharged an unknown amount on August 14th and 15th. An additional 2.60 inches of rain fell on August 26th and resulted in discharges of 18 million gallons from Wilmette, 42 million gallons from Waukegan and more than 7 million gallons from North Chicago between August 26th and the 29th. Thirteen of the twenty-one (62%) violations of the IDPH swimming standard (consecutive samples > 500) in 1987

Table 21. Summary of fecal coliform counts (No./100mL) at 51 Illinois Lake Michigan beaches June through September 10, 1987.

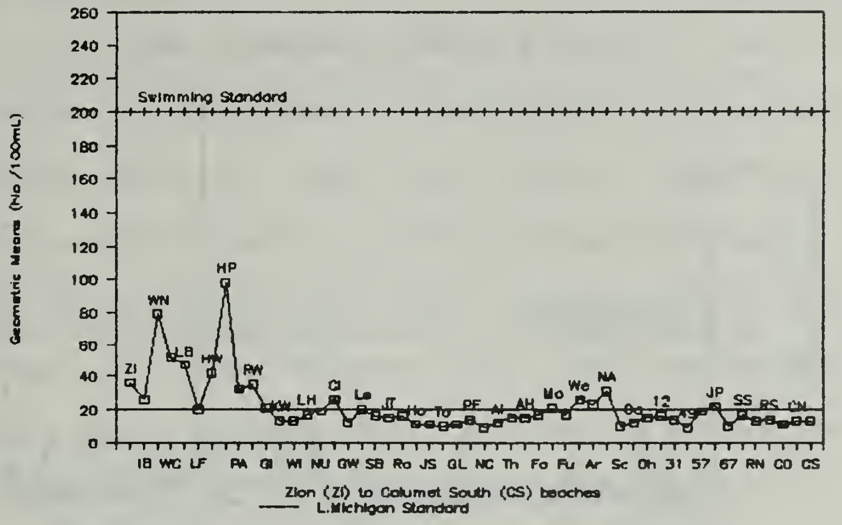
Testing Agency	Beaches	No. of Samples	Minimum	Maximum	Median	Percent >400	Geometric Mean	Consecutive Samples >500
(1)	Zion	94	2	2500	20	6.4	36	1
(1)	IL Beach State Park	91	2	600	20	4.4	26	0
(1)	Waukegan North	93	4	4200	70	12.9	79	1
(1)	Waukegan Central	93	5	2000	50	4.3	52	1
(1)	Lake Bluff	87	2	2200	30	9.2	47	1
(1)	Lake Forest	94	2	640	10	2.1	20	0
(1)	Highwood	90	10	5600	20	7.8	42	1
(1)	Highland Park (Moraine)	93	10	10000	70	23.7	98	9
(1)	Park Avenue	94	10	1600	20	5.3	32	3
(1)	Rosewood	92	5	2000	20	8.7	35	1
(2)	Glencoe	81	1	368	30	0.0	21	0
(2)	Kenilworth	81	1	1040	12	3.7	13	0
(3)	Wilmette	98	1	236	12	0.0	13	0
(2)	Lighthouse	82	1	1120	16	4.9	17	0
(2)	Northwestern University	83	1	2186	20	3.6	19	0
(2)	Clark	82	1	1676	27	3.7	26	0
(2)	Greenwood	82	1	304	12	0.0	12	0
(2)	Lee	82	1	500	24	2.4	20	0
(2)	South Boulevard	80	1	600	19	3.8	16	0
(4)	Sam Leone; Juneway Terrace	88	3	192	12	0.0	15	0
(4)	Rogers	88	1	320	16	0.0	16	0
(4)	Howard	88	1	520	8	1.1	11	0
(4)	Jarvis/Sherwin	88	3	280	12	0.0	11	0
(4)	Loyola; Touhy	88	1	300	8	0.0	10	0
(4)	Greenleaf	88	1	262	12	0.0	11	0
(4)	Pratt/Farwell	88	1	1180	12	3.4	14	0
(4)	Hartigan; N. Shore/Columbia	88	1	270	8	0.0	9	0
(4)	Albion	88	3	1070	8	1.1	12	0
(4)	Thorndale	86	1	1670	10	2.3	15	0
(4)	Ardmore/Hollywood	88	3	2500	12	3.4	15	0
(4)	Foster	88	3	500	16	3.4	17	0
(4)	Montrose	88	3	2100	20	1.1	21	0
(4)	Fullerton	88	3	340	20	0.0	17	0
(4)	Webster	88	3	4079	28	2.3	26	0
(4)	Armitage	88	3	1940	26	1.1	23	0
(4)	North Avenue	88	3	7300	32	4.5	31	0
(4)	Schiller	88	1	1500	6	2.3	10	1
(4)	Oak Street	88	3	2010	12	2.3	12	0
(4)	Ohio Street	88	1	3000	12	4.5	15	2
(4)	12th Street	88	3	3200	16	1.1	16	0
(4)	31st Street	88	3	284	11	0.0	14	0
(4)	49th Street	88	3	572	4	1.1	9	0
(4)	57th Street	88	3	18200	20	3.4	19	0
(4)	Jackson Park	88	3	8600	24	4.5	22	0
(4)	67th Street	88	1	3000	6	2.3	10	0
(4)	South Shore	88	3	800	16	2.3	17	0
(4)	Rainbow North	88	3	640	12	1.1	13	0
(4)	Rainbow South	88	3	810	12	1.1	14	0
(4)	Calumet Outer	88	1	260	10	0.0	11	0
(4)	Calumet North	88	3	300	12	0.0	13	0
(4)	Calumet South	88	3	232	9	0.0	13	0

(1) Lake Co. Health Dept. and North Shore S.D.
(2) Evanston-North Shore Health Department
(3) Village of Wilmette
(4) Chicago Park District

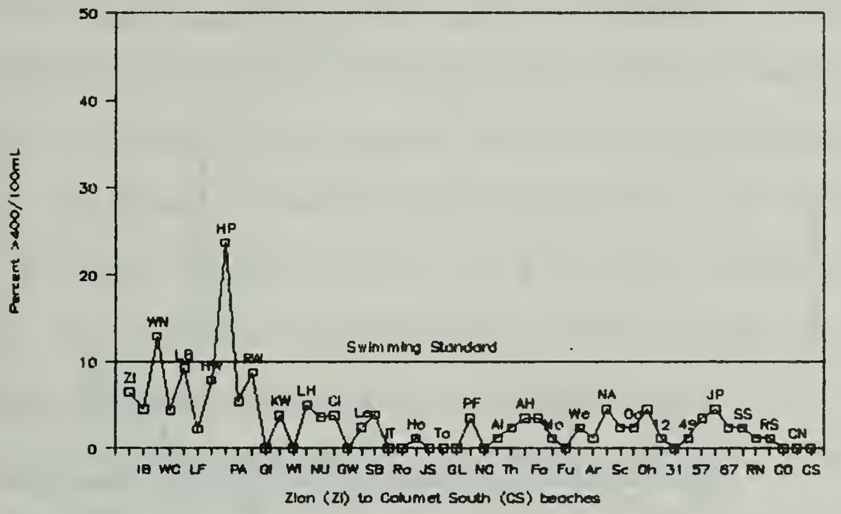
Note; Winthrop Harbor, Foss Park and Devon beaches were closed in 1987 due to high lake levels.
Winnetka Park District did not provide data for Tower, Lloyd, Maple and Elder beaches.

Figure 21. Illinois Lake Michigan beach quality, 1987.

Fecal Coliform Geometric Means



Percent Fecal Coliform Samples >400



Consecutive Fecal Coliform Samples >500

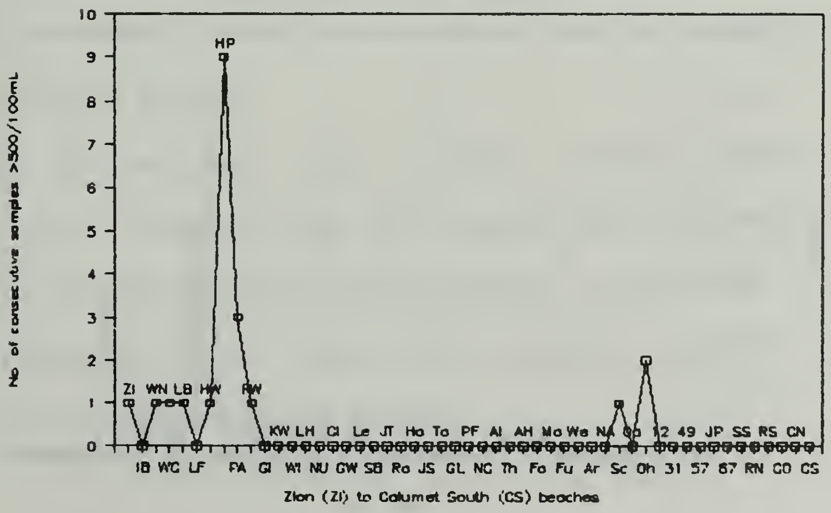
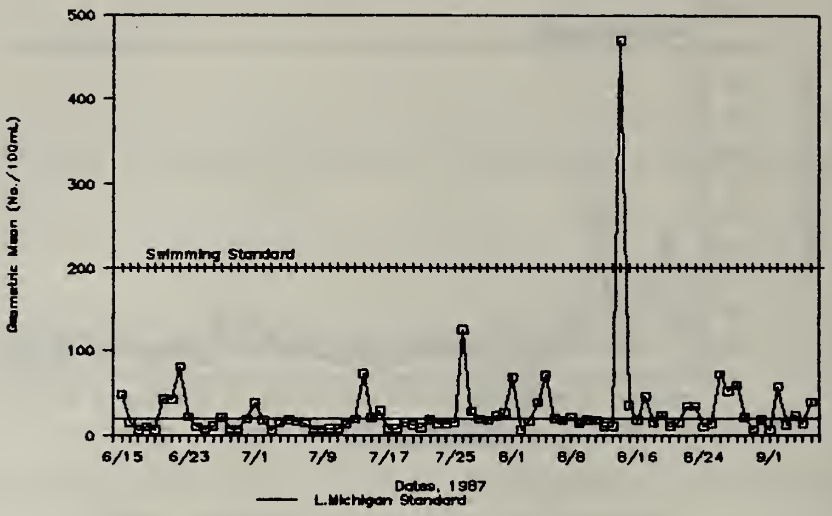
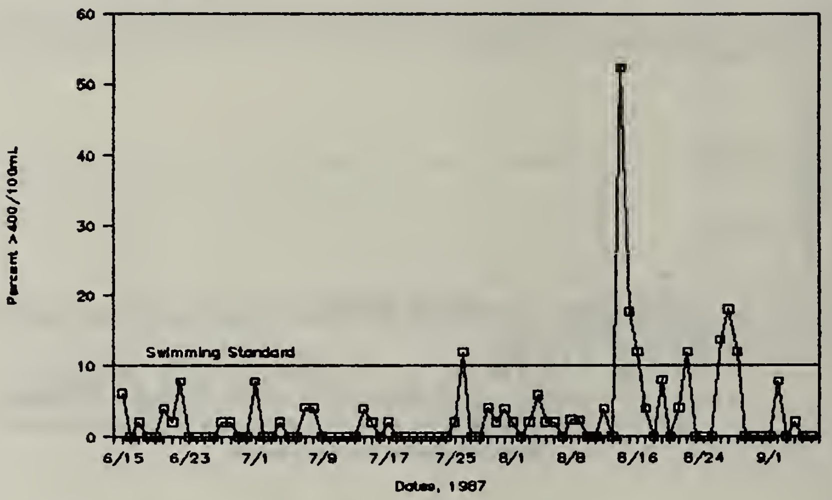


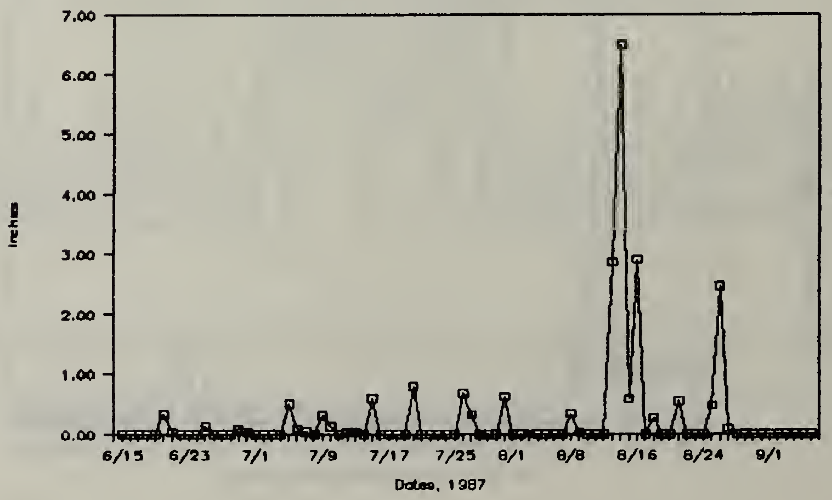
Figure 22. Daily fecal coliform levels for fifty-one Illinois Lake Michigan beaches compared with rainfall at O'Hare Airport June 15 to September 6, 1987.



Daily fecal coliform geometric means



Percent of fecal coliform samples >400



Rainfall at O'Hare Airport

were found during the period of August 14th through the 28th and included Highland Park (3), Park Avenue (3), Ohio Street (2), Zion (1), Waukegan Central (1), Highwood (1), Rosewood (1) and Schiller (1) beaches (Figure 20).

Fecal coliform levels for 1983 through 1987 are summarized in Table 22. The number of consecutive samples exceeding 500 was much higher in 1986 and 1987 then over the preceeding three years. However, the percent of samples over 400 has been well below 10% every year. Only one geometric mean has exceeded 200 and medium geometric means have been 20 or less over these five years.

Most of the violations of swimming standards from 1983 through 1987 were found at Highland Park beach (Table 23). Forty-nine percent of all consecutive samples above 500 were found at this beach. Twenty-one percent of the samples at Highland Park exceeded 400 and the only geometric mean to exceed 200 was found here. The IEPA investigated the area on September 10, 1986 finding a broken sanitary sewer line with flow subsequently entering Lake Michigan. The flow was estimated to be 25,000 gallons per day. Other minor discharges of sewage into ravines tributary to Lake Michigan were also found. After being notified of this problem, the City of Highland Park repaired the sewer line on September 13, 1986. A discharge upstream of the broken line, caused by an obstruction, was also taken care of the same day. Highland Park is under a compliance schedule and is presently undergoing a sewer rehabilitation project.

Four other beaches have also exceeded swimming standards relatively often (Table 23). Three of them are located near the Highland Park beach and may be influenced by the problems there. Excursions of the swimming standard at Waukegan North beach were probably due to combined sewer overflows from the NSSDs Waukegan Plant.

Table 22. Summary of fecal coliform counts (No./100mL) at Illinois Lake Michigan beaches, 1983 - 1987.

	1983	1984	1985	1986	1987	Total
Number of Beaches	58	58	58	57	51	282
Number of Samples	5108	4334	4741	4716	4486	23385
Percent Samples >400 *	2.5	2.9	1.5	4.6	3.1	2.9
Consecutive Samples >500 **	7	7	3	33	21	71
Median Geometric Mean	17	20	15	19	16	17
Percent Geometric Means >200 *	0.0	0.0	0.0	1.8	0.0	0.4
Percent Geometric Means >20 ***	31.0	46.6	31.0	43.8	29.4	36.5

Table 23. Summary of fecal coliform counts (No./100mL) at five Illinois Lake Michigan beaches, which exceeded swimming standards most often, 1983 - 1987.

1983 - 1987	Highland Park	Rosewood	Waukegan North	Highwood	Park Ave.	Total
Number of Samples	432	434	434	425	431	2156
Percent Samples >400 *	20.8	11.5	9.9	6.4	5.6	10.8
Consecutive Samples >500 **	35	4	6	4	5	54
Median Geometric Mean	50	30	40	22	28	30
Number Geometric Means >200 *	1	0	0	0	0	1
Number Geometric Means >20 ***	5	5	5	4	5	24

* General Use (swimming) Standard (35 IL Adm. Code 302)
** Swimming Criterion (IDPH,1987)
*** Lake Michigan Standard (35 IL Adm. Code 302)

SECTION F

STATUS OF DISCHARGERS

The water quality of the southwest portion of Lake Michigan has improved substantially since 1968 as evidenced by reduced levels of total coliform, ammonia nitrogen, total phosphate and decreased occurrences of beach closings. This improvement is primarily due to diversion of municipal and industrial treated wastewater discharges from Lake Michigan to the DesPlaines River Basin. The chronology of diversions are summarized below:

1974	Highland Park STP (all flows); Lake Forest STP (Dry weather flows); Lake Bluff STP (Dry weather flows).
1975	Lake Bluff STP (Wet weather flows); United States Steel-South Works (Process wastewater).
1976	North Chicago STP (Dry weather flows); Great Lakes Naval Training Center STP (all flows); Abbott Laboratories (Process wastewater).
1977	Fort Sheridan STP (all flows); United States Steel-Waukegan Works (Process wastewater); Chicago's Jardine and South Water Purification Plants (backwash).
1978	Lake Forest STP (Wet weather flows); Waukegan STP (Dry weather flows).

In addition to these diversions the Hammond, Indiana Sanitary District began tertiary treatment in 1978.

Abbott Laboratories and Commonwealth Edison Company's Waukegan and Zion station's continue to discharge cooling water into Lake Michigan. Treatment facilities at the Waukegan station for non-thermal discharges are in compliance with their National Pollution Discharge Elimination System (NPDES) permits. The Highwood water filtration plant continues to discharge backwash water directly to Lake Michigan.

NORTH SHORE SANITARY DISTRICT (NSSD)

Excess wet weather flows continue to be discharged into Lake Michigan from NSSD's North Chicago and Waukegan treatment plants after settling and disinfection (Figure 20). There were 37 overflows totaling 322.26 million gallons at the Waukegan Plant and 11 overflows totaling more than 22 million gallons at the North Chicago Plant in 1987 (Table 24). North Chicago averaged 28 events/year and Waukegan averaged 27 events/year from 1980 to 1985, with total annual flows ranging from 28.59 MG to 111.0 MG at North Chicago and 97.01 MG to 655.20 MG at Waukegan (City of Chicago and IEPA, 1987). If the 201 facilities plan improvements are made at the Waukegan, North Chicago and Gurnee plants, the projected year 2000 overflow events would be reduced to 7/year with a volume of 20.6 MG/year at North Chicago and 4/year with a volume of 19.8 MG/year at Waukegan (Donohue and Associates, 1984).

These combined sewer overflows (CSO) events are partially responsible for some of the violations of the swimming criterion (consecutive samples >500/100 mL fecal coliform) at area beaches. In addition, these overflows have frequently exceeded the Lake Michigan basin effluent standard of 1.0 mg/L total phosphorus (City of Chicago and IEPA, 1987). In 1987, the mean

Table 24. Combined sewer overflows in million gallons at North Shore Sanitary District's Waukegan and North Chicago WWTPs, 1987 (NSSD, 1988).

Date	Waukegan	North Chicago
March 1		5.90
April 11		*
April 12		0.64
April 14		3.98
April 15	31.76	4.50
April 16	14.10	*
April 17	10.05	
April 18	7.24	
April 19	3.31	
April 20	3.16	
April 21	1.26	
April 22	16.64	
April 23	18.03	
April 24	9.67	
April 25	6.43	
April 26	3.89	
April 27	2.48	
May 2	14.46	
May 3	9.00	
May 4	3.69	
August 14	13.23	*
August 15	17.66	*
August 16	10.70	
August 17	18.94	
August 18	9.62	
August 19	4.20	
August 26	20.28	5.16
August 27	15.03	1.96
August 28	6.25	*
August 29	0.20	
December 9	1.22	
December 10	0.21	
December 20	18.09	
December 21	8.09	
December 22	2.98	
December 23	1.17	
December 24	5.60	
December 25	7.67	
December 26	3.36	
December 27	1.90	
December 28	0.69	
Number of Overflows	37	11
Total Flow (MG)	322.26	*22.34
Mean Flow (MGD)	8.71	*3.69

* Flow data incomplete.

(±SD) total phosphorus concentrations were 0.98 (± 0.42) mg/L and 1.87 (± 0.94) mg/L at the Waukegan and North Chicago CSOs respectively. Forty-six percent of Waukegan samples and 78% of North Chicago samples exceeded the 1.0 mg/L standard. NSSD has filed a petition with the Illinois Pollution Control Board to amend the total phosphorus effluent standard [35 Ill. Adm. Code 304.123(a)]. The proposed amendment would exempt the CSO discharges from North Chicago and Waukegan from the standard.

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO (MSDGC)

Wastewater from all lake shore municipalities in Cook County are treated by MSDGC treatment facilities. Treated effluents and combined sewer overflows are discharged to a system of waterways tributary to the DesPlaines River. Historically, the Chicago and Calumet Rivers were tributaries of Lake Michigan. To avoid contamination of the City's drinking water supply, MSDGC constructed a canal system which reversed the direction of flow away from Lake Michigan to the DesPlaines River Basin. Dilution of waste flows is provided by diversion of water from Lake Michigan at the Wilmette Pumping Station, Chicago River Controlling Works and the O'Brien Lock and Dam. The monthly average diversion allowed by a 1967 court decree is 3200 cfs (2068 MGD). To prevent flooding during periods of heavy rain, MSDGC bypasses flows from the District's waterways to Lake Michigan at Wilmette, Chicago River and O'Brien Lock and Dam (Figure 20).

Between 1968 and 1987 there have been 38 bypasses, most of these have occurred at Wilmette (74%) (Table 25). Bypasses during this period have averaged about 2 per year with a mean volume per event of 187 million gallons. Total annual volumes have ranged from zero in 1970, 71, 73, 74 and 1984 to 1975 MG in 1987.

Table 25. Dates, locations and volumes (million gallons) released during bypasses to Lake Michigan at the Wilmette Pumping Station, Chicago River Controlling Works and the O'Brien Lock and Dam, 1968 - 1987.

Date	Wilmette Pumping Station	Chicago River Controlling Works	O'Brien Lock and Dam
August 14, 1987		985.9	
August 14-15, 1987	971.0		
August 26, 1987	18.0		
October 3, 1986	53.1		
March 4, 1985	112.2		
August 6, 1985	58.3		
August 17, 1983	112.2		
October 22, 1983	10.5		
July 22, 1982	2.5		
August 7, 1982		83.0	
December 3, 1982	142.9	247.6	124.2
April 28, 1981	24.5		
May 29, 1981	10.5		
June 13, 1981			377.0
July 12, 1981	202.0		
August 14, 1981	98.0		
July 21, 1980	157.8	184.0	
March 4, 1979	44.9		
April 11-12, 1979	11.2		
September 13, 1978	32.9		
September 17, 1978	98.7		
June 11, 1977	40.4		
June 30, 1977	29.2	297.0	
April 24, 1976	134.6		
April 18, 1975	89.8	1129.6	
August 21, 1975	130.2		
June 14, 1972	20.2		
August 25, 1972	190.8	59.1	
September 17, 1972	89.8		
October 10, 1969	62.8		
August 15-17, 1968		533.4	
August 16-17, 1968	154.1		
Number of Bypasses	28	8	2
Total Volume (MG)	3103.1	3519.6	501.2
Mean Volume (MG)	110.8	440.0	250.6

The Tunnel and Reservoir Plan (TARP) adopted by MSDGC consists of conveyance tunnels (Phase I) and storage reservoirs (Phase II) to transport and store combined sewer overflows during periods of heavy rainfall. Subsequently, these flows, which are presently discharged to the waterways, would be pumped to MSDGC facilities for treatment. Bypasses to Lake Michigan and resulting beach closings will essentially be eliminated (90%) when Phase I implementation is completed.

Thirty-one of 40 miles of the mainstream segment of TARP was placed into operation in May, 1985. The present storage capacity of this segment is 830 million gallons. Nine of 28 miles of the Calumet section was placed into operation in March, 1986. The present storage capacity of the Calumet section is 180 million gallons. In 1988, MSDGC awarded two contracts for construction of 14 miles of the Des Plaines segment. When this segment is completed it will have a capacity of 257 million gallons.

JOHNSON OUTBOARDS, DIVISION OF OUTBOARD MARINE CORPORATION, (Waukegan Harbor)

The facility manufactures and assembles outboard motors in plant Nos. 1 and 2. Plant No. 3 which once served as an export shipping and service school is no longer being operated by OMC. Plant No. 1 was placed in operation in 1926 and it is the site where outboard motors are assembled, painted, tested and shipped. At this plant there are located one (1) harbor intake and five (5) NPDES permitted outfalls (007, 008, 014, 015, 016). From these outfalls are discharged non-contact cooling water, stormwater runoff and roof drainage. Discharges from plant No. 1 enter Lake Michigan via Waukegan Harbor. Discharges from plant No. 2 enter Lake Michigan via North Ditch located north of the facility, except for outfalls 007 and 008, which discharges directly to Lake Michigan.

Process wastewater from electroplating, heat treating, chromate conversion coating are pretreated prior to being discharged to the North Shore Sanitary District for further treatment.

During 1975 and 1976, polychlorinated biphenyls (PCBs) were found in several discharges. The PCBs had been used as a hydraulic fluid in die cast machines from approximately 1961 to 1972. The sediments in Waukegan Harbor and the North Ditch are grossly contaminated with PCBs (Figure 23) with a maximum concentration of 500,000 mg/kg (IJC, 1982). The USEPA has classified sediments with PCB concentrations greater than 10 mg/kg as heavily polluted (USEPA, 1977). PCBs are also present in water (concentrations up to several ug/L) and in fish (maximum average concentration 77.4 mg/kg) (IJC, 1982). The USFDA action level for PCBs in fish is 2.0 mg/kg. Signs have been posted warning the public not to eat fish caught in the harbor.

After over ten years of litigation and negotiations (Table 26) a Consent Decree, signed by the United States, the State of Illinois and Outboard Marine Corporation, has been lodged with the United States District Court for the Northern District of Illinois. The Consent Decree sets forth the remedial action which will be undertaken to clean up the OMC Waukegan Harbor site in Waukegan, Illinois (USEPA, 1988). OMC will pay the entire cost by setting up a 20 million dollar trust fund to finance the four year cleanup effort.

Figure 23. Sediment concentrations of PCBs at the Outboard Marine Corporation / Waukegan Harbor site. (USEPA, 1988)

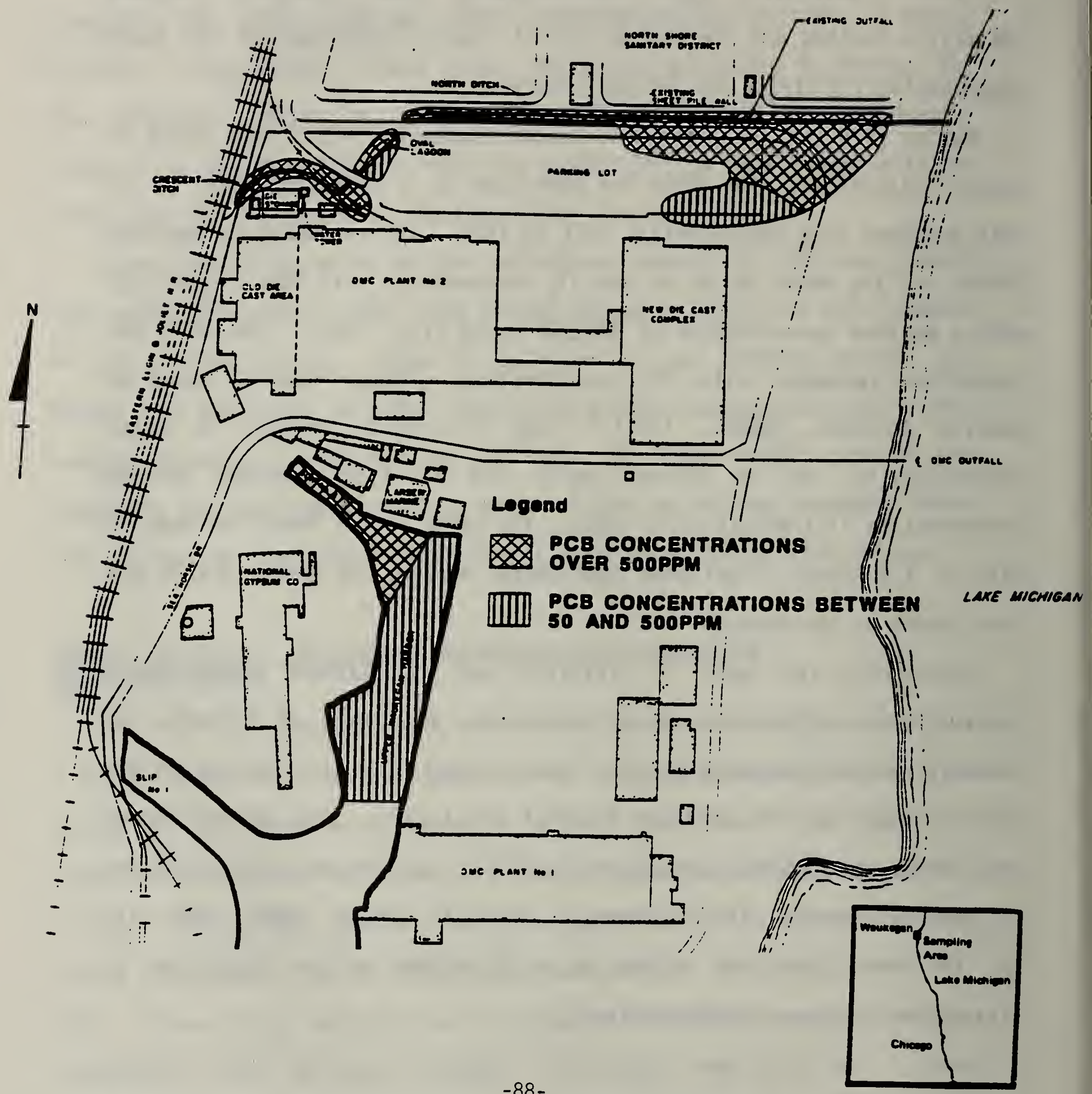


Table 26. Outboard Marine Corporation/Waukegan Harbor site history of events (USEPA, 1988).

1978	U.S. EPA files suit against OMC to clean up PCB contamination in Waukegan Harbor and on OMC property.
1980	Congress enacts CERCLA (Superfund) bill, enabling the federal government to finance the cleanup of hazardous substances.
1982	U.S. EPA includes the OMC/Waukegan Harbor site on the first proposed National Priorities List which qualifies the site for federal cleanup funds under Superfund.
1983	U.S. EPA completes a Feasibility Study examining options for cleanup at the site and public comments are solicited.
1984	U.S. EPA chooses a remedial alternative for the site and signs a Record of Decision authorizing $21 million for cleanup.
	U.S. Army Corps of Engineers begins design work for selected remedial action.
1985	U.S. EPA's 1978 lawsuit against OMC is dismissed, while allowing for a future suit under Superfund to recover government costs for cleanup.
	OMC denies U.S. EPA access to property to continue remedial design work.
	EPA obtains an administrative warrant to enter property to complete design work.
	OMC obtains a stay of the warrant and protracted legal Proceedings result.
1986	EPA appeals decision allowing OMC to deny access to property to the U.S. Supreme Court.
	Superfund Amendments and Reauthorization Act (SARA) is enacted granting EPA access authority to implement Superfund remedies.
	EPA and OMC agree to end ongoing access litigation and begin negotiations to clean up site.
1988	Negotiations between EPA and OMC result in a Consent Decree and recommended remedial alternative to permanently clean OMC/Waukegan Harbor site.

SECTION G

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APPENDIX I

SURVEY DATA SUMMARIES

Appendix I-1

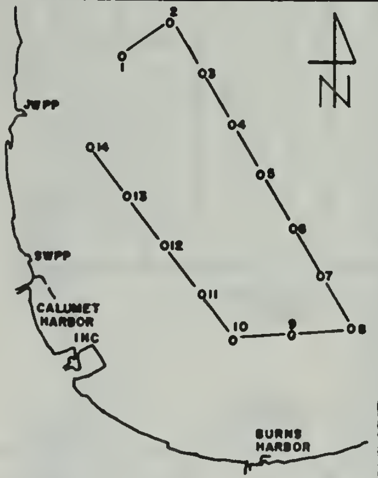
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

CHICAGO-LAKE MICHIGAN OPEN WATER SURVEY

DATE April 29, 19 87



PARAMETER	STORET NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
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TIME		0856	0914	0932	0950	1008	1026	1044	1102	1120	1138	1156	1214	1232	1250
TEMPERATURE °C	00010	10	8	7	7	7	7	7	8	8	9	9	9	9	10
TURBIDITY F.T.U.	00076	2.1	1.3	1.3	1.1	0.80	0.75	0.80	0.80	0.90	1.0	0.90	1.0	1.3	1.7
ODOR, THRESHOLD	00086	10f	20f	20M	10M	2M	2M	2M	1M	20M	1M	1M	1M	1M	2M
pH	00400	8.3	8.3	8.3	8.3	8.3	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	20.1	20.5	19.8	20.2	20.4	21.3	20.1	20.1	20.1	20.1	20.4	20.3	20.4	20.1
CHLORIDE mg/L	00940	9.2	9.1	9.1	9.1	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.4	9.2
PHOSPHATE, TOTAL mg/L	00650	0.06	0.02	0.03	0.02	0.03	0.03	0.05	0.03	0.01	0.03	0.02	0.04	0.03	0.03
PHOSPHATE, DISSOLVED mg/L	00653	0.01	0.01	<.01	0.01	0.02	0.02	0.01	0.01	<.01	0.02	0.01	<.01	0.03	0.01
SILICA mg/L	00956	0.26	0.30	0.31	0.36	0.38	0.41	0.38	0.34	0.33	0.29	0.34	0.36	0.33	0.26
POTASSIUM mg/L	00937	1.2	1.3	1.3	1.2	1.2	1.3	1.2	1.2	1.3	1.3	1.3	1.2	1.2	1.3
SODIUM mg/L	00929	4.7	4.5	4.8	4.4	4.5	4.5	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
CONDUCTIVITY μ mhos	00095	280	285	285	285	285	285	285	285	285	285	285	285	285	285
RESIDUE, FILTRABLE mg/L	00515	146	133	151	144	137	139	136	132	140	142	141	138	143	131
RESIDUE, NONFILTRABLE mg/L	00530	0	0	0	1	1	0	0	0	0	0	0	2	0	0
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	<.01	0 .02	<.01	<.01	0.07	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
NITROGEN, ORGANIC mg/L	00605	0.15	0.14	0.14	0.15	0.14	0.28	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
PLATE COUNT 48Hr., 35°C PER mL	31753	16	30	7	2	3	0	5	0	10	2	3	6	4	5
MF-TC PER 100 mL	31503	80	140	0	0	0	0	0	0	0	0	0	0	0	0
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	0	0	0	0	0	0	2	0	0	0	0	0	0	0
PLANKTON PER mL	60050	720	570	1440	690	130	840	60	60	150	750	360	270	420	390
ACTINOS 14 DAY, 26°C PER mL	80148	2	4	2	2	1	0	2	1	5	4	3	1	3	4
FUNGI PER mL	31856	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ASBESTOS PER L	00948	.	3.38×10^5	-	4.32×10^5	-	3.92×10^5	-	3.89×10^5	-	4.08×10^5	-	5.22×10^5	-	-

METEOROLOGICAL DATA

TIME		0800	0900	1000	1100	1200	1300	1400
DIRECTION	00036	W	NW	NW	N	NW	N	N
VELOCITY	00035	15	18	12	10	10	5	10

PREVAILING WIND 00036 N

SURVEY BY: J. Vencill/K. Rudmin/J. Rak

REMARKS:
Sunny and clear , Waves 2-4'
w/small to moderate swells
increasing throughout the day

Appendix I-2

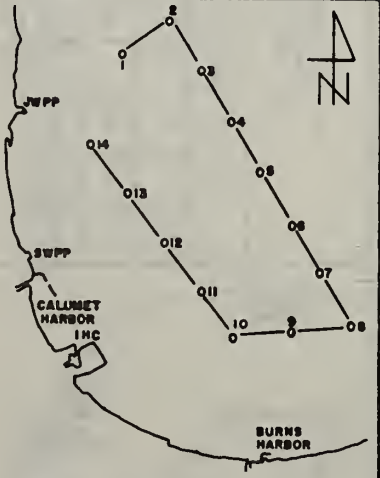
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

CHICAGO-LAKE MICHIGAN OPEN WATER SURVEY

DATE June 23, 1987



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TEMPERATURE °C	00010	22	22	22	22	22	22	22	22	23	23	23	23	23	23
TURBIDITY F.T.U.	00076	0.25	0.50	0.30	0.35	0.25	0.35	0.35	0.35	0.35	0.40	0.30	0.30	0.30	0.30
ODOR, THRESHOLD	00086	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1DM
pH	00400	8.5	8.6	8.6	8.5	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
SULFATE mg/L	00945	19.2	19.4	19.3	19.8	19.3	19.9	19.9	20.0	20.0	19.9	19.8	19.6	19.9	20.0
CHLORIDE mg/L	00940	9.0	8.9	9.0	9.0	9.0	9.2	9.0	9.2	9.1	9.2	9.2	9.1	9.1	9.1
PHOSPHATE, TOTAL mg/L	00650	0.01	0.01	0.01	0.01	0.02	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01
PHOSPHATE, DISSOLVED mg/L	00653	<0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SILICA mg/L	00956	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
POTASSIUM mg/L	00937	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.6	1.6	1.7	1.6	1.7
SODIUM mg/L	00929	5.4	5.2	5.6	5.3	5.2	5.3	5.4	5.5	5.3	5.4	5.3	5.3	5.3	5.3
CONDUCTIVITY µ mhos	00095	285	280	290	290	285	285	285	285	280	285	285	285	285	285
RESIDUE, FILTRABLE mg/L	00515	132	154	145	159	187	178	191	188	178	179	179	170	181	178
RESIDUE, NONFILTRABLE mg/L	00530	2	3	2	3	2	2	3	5	4	3	3	3	4	4
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6.2
NITROGEN, AMMONIA mg/L	00610	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.27	0.26	0.26	0.27	0.26	0.28	0.27	0.28	0.27	0.28	0.29	0.29	0.30	0.30
NITROGEN, ORGANIC mg/L	00605	0.14	0.14	0.14	0.15	0.15	0.15	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15
PLATE COUNT 48hr., 35°C PER mL	31753	0	0	1	0	0	0	0	0	0	3	0	0	0	0
MF-TC PER 100 mL	31503	0	0	0	0	2	0	0	0	0	0	0	0	0	0
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	60	30	0	30	150	30	150	30	30	30	150	90	30	0
ACTINOS 14 DAY, 26°C PER mL	80148	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FUNGI PER mL	31856	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASBESTOS PER L	00948	-	4.71×10^5	-	6.28×10^4	-	6.28×10^4	-	4.71×10^4	-	8.63×10^4	-	6.67×10^4	-	7.85×10^4

METEOROLOGICAL DATA

TIME		0800	0900	1000	1100	1200	1300	1400
DIRECTION	00036	N	NE	NE	NE	NE	NE	NE
VELOCITY	00035	6	4	7	6	6	6	7

SURVEY BY: J. Vencill/G. Slowik/J.Rak

PREVAILING WIND 00036 NE

REMARKS:
Weather Conditions: Clear and sunny with early morning haze.
Lake Conditions: Waves 1-2' w/small lake swells

Appendix I-3

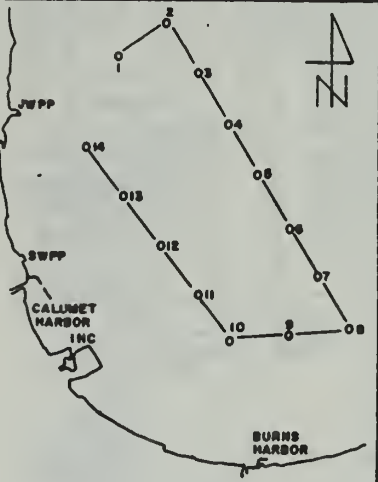
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

CHICAGO-LAKE MICHIGAN OPEN WATER SURVEY

DATE August 19, 1987



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER													
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		CHW201	CHW202	CHW203	CHW204	CHW205	CHW206	CHW207	CHW208	CHW209	CHW210	CHW211	CHW212	CHW213	CHW214
TIME		0916	0934	0952	1010	1028	1046	1104	1122	1140	1158	1216	1234	1252	1310
TEMPERATURE °C	00010	23	23	24	24	24	24	24	24	24	25	25	24	24	25
TURBIDITY F.T.U.	00076	0.55	0.65	0.60	0.55	0.70	0.50	0.55	0.60	0.70	0.70	0.75	0.65	0.60	0.65
ODOR, THRESHOLD	00086	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
SULFATE mg/L	00945	20.2	20.2	20.5	20.9	20.5	20.8	21.2	20.9	21.3	21.2	20.7	21.4	21.1	20.8
CHLORIDE mg/L	00940	8.5	8.5	8.7	8.8	8.8	9.0	8.8	8.9	8.9	9.1	8.6	8.6	8.6	8.6
PHOSPHATE, TOTAL mg/L	00650	0.01	0.01	0.02	0.01	<.01	0.01	0.02	0.01	<.01	<.01	0.02	0.01	0.01	0.02
PHOSPHATE, DISSOLVED mg/L	00653	<.01	<.01	<.01	<.01	<.01	<.01	0.01	<.01	<.01	<.01	0.01	<.01	<.01	<.01
SILICA * mg/L	00956	0.18	0.18	0.16	0.16	0.17	0.20	0.22	0.22	0.23	0.23	0.14	0.14	0.14	0.15
POTASSIUM mg/L	00937	1.3	1.3	1.3	1.2	1.3	1.5	1.7	1.4	1.4	1.2	1.2	1.2	1.2	1.2
SODIUM mg/L	00929	5.8	5.4	5.7	5.4	5.4	5.8	6.6	6.2	5.7	6.2	5.3	5.4	5.6	5.1
CONDUCTIVITY µ mhos	00095	280	280	285	285	285	285	285	285	285	285	275	280	280	280
RESIDUE, FILTRABLE mg/L	00515	162	162	163	170	160	158	177	171	176	176	165	174	166	171
RESIDUE, NONFILTRABLE mg/L	00530	5	2	4	3	4	2	3	1	2	2	0	0	0	0
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.05
NITROGEN, NITRITE-NITRATE mg/L	00630	0.22	0.22	0.22	0.20	0.21	0.21	0.21	0.21	0.23	0.23	0.23	0.22	0.22	0.22
NITROGEN, ORGANIC mg/L	00605	0.16	0.16	0.16	0.14	0.16	0.18	0.17	0.16	0.14	0.18	0.16	0.16	0.17	0.18
PLATE COUNT 48hr., 35°C PER mL	31753	4	5	5	2	1	3	4	2	4	1	1	6	4	5
MF-TC PER 100 mL	31503	0	0	0	0	0	0	0	8	0	6	0	0	0	0
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	0	0
PLANKTON PER mL	60050	90	60	150	120	60	0	60	30	960	240	0	480	180	330
ACTINOS 14 DAY, 26°C PER mL	80148	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FUNGI PER mL	31856	1	0	0	1	1	0	0	2	2	1	3	1	1	4
ASBESTOS X10^5 PER L	00948	-	4.08	-	3.89	-	1.73	-	3.92	-	3.34	-	4.16	-	3.27

METEOROLOGICAL DATA

TIME		0800	0900	1000	1100	1200	1300	1400
DIRECTION	00036	NW	N	NE	NE	N	N	N
VELOCITY	00035	10	5	8	10	12	10	10

PREVAILING WIND

00036 N

SURVEY BY: J. Vencill/J. Rak

REMARKS: Weather and Lake conditions:
Sunny and clear. Air Temperatures in high seventies to low eighties:
Waves 2'-4' w/small to moderate lake swells and northerly winds

* Lower detection limit due to longer light path

Appendix I-4

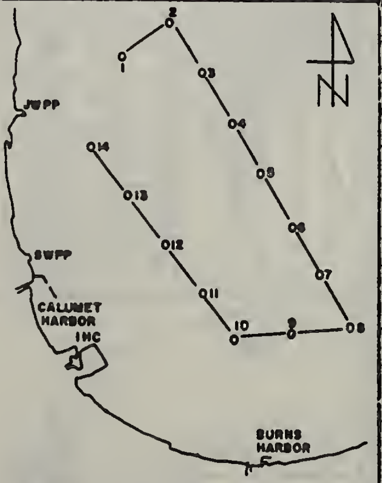
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

CHICAGO-LAKE MICHIGAN OPEN WATER SURVEY

DATE NOVEMBER 3, 19 87



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14
		CHW201	CHW202	CHW203	CHW204	CHW205	CHW206	CHW207	CHW208	CHW209	CHW210	CHW211	CHW212	CHW213	CHW214
TIME		0913	0931	0949	1007	1025	1043	1101	1119	1137	1155	1213	1231	1249	1307
TEMPERATURE °C	00010	13	13	13	13	13	13	13	13	13	13	13	13	13	13
TURBIDITY F.T.U.	00076	0.40	0.30	0.40	0.30	0.35	0.35	0.35	0.50	0.50	0.45	0.40	0.35	0.35	0.45
ODOR, THRESHOLD	00086	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	21.7	22.0	22.0	22.2	22.0	22.2	22.2	22.2	22.2	22.4	22.2	22.4	22.5	22.5
CHLORIDE mg/L	00940	8.9	9.1	9.0	9.0	9.0	9.0	8.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0
PHOSPHATE, TOTAL mg/L	00650	0.02	0.04	0.02	0.04	0.04	0.04	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.03
PHOSPHATE, DISSOLVED mg/L	00653	<0.01	<0.01	0.01	0.01	0.02	0.01	0.01	< 0.01	0.01	0.02	0.02	0.01	<0.01	0.01
SILICA mg/L	00956	0.08	0.16	0.17	0.19	0.17	0.19	0.21	0.23	0.23	0.19	0.17	0.15	0.18	0.10
POTASSIUM mg/L	00937	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
SODIUM mg/L	00929	5.2	5.3	5.2	5.3	5.3	5.2	5.2	5.2	5.2	5.2	5.1	5.2	5.2	5.2
CONDUCTIVITY μ mhos	00095	290	285	285	285	285	285	285	280	285	285	285	280	280	285
RESIDUE, FILTRABLE mg/L	00515	149	147	147	148	145	158	141	157	149	151	149	148	155	144
RESIDUE, NONFILTRABLE mg/L	00530	3	3	2	2	1	2	4	2	3	3	2	0	3	2
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	< 5	< 5	< 5	< 5	9.1	8.8	< 5	< 5	<5
NITROGEN, AMMONIA mg/L	00610	<0.01	<0.01	0.01	< 0.01	0.01	0.01	0.01	0.02	<0.01	0.01	0.02	<0.01	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.17	0.20	0.20	0.21	0.21	0.22	0.22	0.22	0.21	0.20	0.20	0.19	0.20	0.19
NITROGEN, ORGANIC mg/L	00605	0.16	0.16	0.16	0.16	0.15	0.16	0.15	0.15	0.17	0.15	0.15	0.16	0.16	0.16
PLATE COUNT 48hr., 35°C PER mL	31753	0	11	22	23	38	7	12	16	11	10	3	0	1	6
MF-TC PER 100 mL	31503	2	0	0	0	0	0	0	0	0	0	0	0	0	2
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANKTON PER mL	60050	420	480	1290	210	480	240	960	870	60	60	540	0	270	210
ACTINOS 14 DAY, 26°C PER mL	80148	1	0	0	0	1	1	0	0	0	0	0	0	0	0
FUNGI PER mL	31856	0	0	1	0	1	1	0	0	0	0	1	0	1	2
ASBESTOS PER L	00948		1.61×10^5		2.03×10^5		2.47×10^5		3.18×10^5		3.22×10^5		3.96×10^5		4.16×10^5

METEOROLOGICAL DATA

TIME		0800	0900	1000	1100	1200	1300	
DIRECTION	00036	W	SW	W	W	W	W	
VELOCITY	00036	12	12	14	14	16	18	

PREVAILING WIND 00036 W

SURVEY BY: J.Vencill/K. Rudmin

REMARKS: Sunny w/Record warm air temperatures
Strong winds
Lake Conditions: Southwesterly fresh winds, 2-4' and increasing throughout the survey. Small lake swells developing to moderate.

Appendix I-5

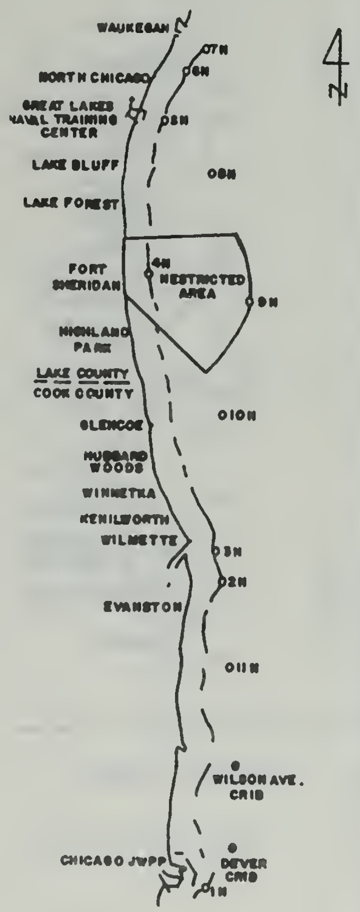
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

NORTH SHORE LAKE SURVEY

DATE May 5, ,19 87



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER									
		1N	2N	3N	5N	6N	7N	8N	9N	10N	11N
		CHW013	CHW011	CHW010	CHW005	CHW004	CHW003	CHW006	CHW008	CHW009	CHW012
TIME		0834	0933	0939	1103	1110	1118	1043	1020	1001	0914
TEMPERATURE °C	00010	12	11	10	11	11	11	9	9	10	10
TURBIDITY F.T.U.	00076	6.0	2.9	2.5	2.6	3.2	4.3	2.4	2.2	2.0	2.4
ODOR, THRESHOLD	00086	3 OF	2 OM	2M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.3	8.3	8.3	8.4	8.4	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	18.8	19.0	19.1	19.2	20.0	20.6	19.7	19.8	20.6	20.3
CHLORIDE mg/L	00940	9.7	9.7	9.6	9.8	10.5	11.0	10.0	10.0	9.6	9.5
PHOSPHATE, TOTAL mg/L	00650	0.06	0.02	0.02	0.03	0.04	0.07	0.03	0.04	0.03	0.03
PHOSPHATE, DISSOLVED mg/L	00653	0.04	< 0.01	< 0.01	< 0.01	0.03	0.03	0.03	0.02	< 0.01	< 0.01
CONDUCTIVITY μ mhos	00095	290	285	290	290	300	305	290	285	290	290
RESIDUE, NONFILTRABLE mg/L	00530	11	7	6	6	4	8	6	6	6	6
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	< 5	<5	<5	<5	<5	<5	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.20	0.22	0.22	0.22	0.27	0.34	0.22	0.22	0.24	0.21
NITROGEN, ORGANIC mg/L	00605	0.16	0.14	0.14	0.18	0.14	0.16	0.18	0.16	0.14	0.14
PHENOL-LIKE SUBSTANCES μg/L	32730	<1	-	<1	<1	-	< 1	-	< 1	-	< 1
PLATE COUNT 48 hr., 35 °C PER mL	31753	34	10	17	6	21	16	6	6	5	7
MF-TC PER 100mL	31503	0	0	0	0	0	0	0	0	0	0
MF-FC PER 100mL	31616	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100mL	31679	0	0	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	780	270	2850	1170	1710	570	90	90	210	1350
ACTINOS 14 DAY, 26°C PER mL	80148	5	3	5	5	10	15	1	7	12	6
FUNGI PER mL	31856	1	0	0	2	1	2	0	0	0	0

METEOROLOGICAL DATA								PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	00036
DIRECTION	00036	NE	NE	E	NE	NE	NE	NE
VELOCITY	00035	6	4	4	5	5	5	

SURVEY BY: J. Vencill/K.Rudmin

REMARKS: Weather & Lake Conditions: Sunny & Clear
W/Light winds from NE to E small lake swells w/2' waves.

Appendix I-6

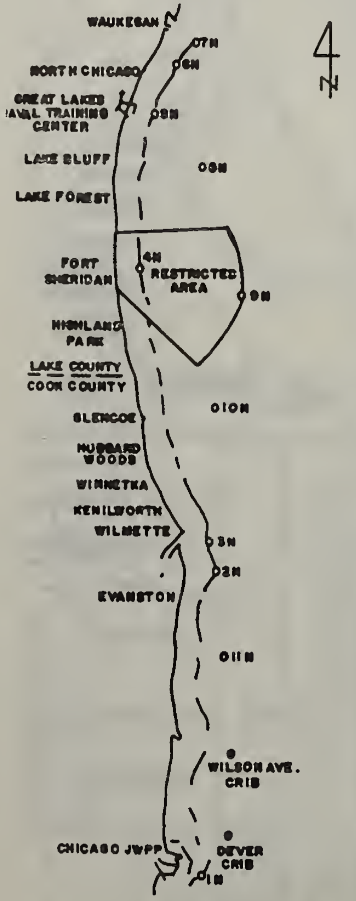
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

NORTH SHORE LAKE SURVEY

DATE June 2, 19 87



PARAMETER		STORET NUMBER	1N CHW013	2N CHW011	3N CHW010	5N CHW005	6N CHW004	7N CHW003	8N CHW006	9N CHW008	10N CHW009	11N CHW012	
TIME			0838	0938	0945	1106	1113	1119	1049	1026	1007	0916	
TEMPERATURE	°C	00010	13	15	15	14	14	14	15	17	16	15	
TURBIDITY	F.T.U.	00076	0.75	0.55	0.60	0.80	0.65	0.70	0.55	0.75	0.55	0.65	
ODOR, THRESHOLD		00086	2 DM	1 M	1 DM	1 DM	1M	1M	1M	1M	1M	1M	
pH		00400	8.4	8.4	8.4	8.4	8.4	8.4	8.5	8.5	8.5	8.5	
SULFATE	mg/L	00945	19.4	19.6	19.9	19.8	19.8	19.9	19.7	20.1	19.9	20.1	
CHLORIDE	mg/L	00940	9.0	9.1	9.1	9.0	9.1	9.0	9.1	9.1	9.0	9.0	
PHOSPHATE, TOTAL	mg/L	00650	0.04	0.02	0.01	< 0.01	0.01	<0.01	0.01	<0.01	0.03	0.02	
PHOSPHATE, DISSOLVED	mg/L	00653	<0.01	0.01	<0.01	<0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	0.01	
CONDUCTIVITY	µ mhos	00095	285	290	290	290	290	285	285	285	290	290	
RESIDUE, NONFILTRABLE	mg/L	00530	5	1	3	4	2	3	2	3	2	4	
OXYGEN DEMAND, CHEMICAL	mg/L	00335	6.1	< 5	< 5	< 5	< 5	< 5	< 5	< 5	<5	<5	
NITROGEN, AMMONIA	mg/L	00610	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.20	0.01	0.01	
NITROGEN, NITRITE-NITRATE	mg/L	00630	0.23	0.23	0.22	0.23	0.24	0.25	0.24	0.24	0.24	0.24	
NITROGEN, ORGANIC	mg/L	00605	0.18	0.18	0.18	0.18	0.18	0.18	0.14	0.14	0.18	0.18	
PHENOL-LIKE SUBSTANCES	µg/L	32730	1	-	1	< 1	-	< 1	-	< 1	-	1	
PLATE COUNT 48 hr., 35°C PER mL		31753	62	2	11	1	1	1	3	1	3	1	
MF-TC PER 100mL		31503	0	0	0	0	2	0	0	0	0	0	
MF-FC PER 100mL		31616	0	0	0	0	0	0	0	0	0	0	
MF-FS PER 100mL		31679	0	0	0	0	0	0	0	0	0	18	
PLANKTON PER mL		60050	3300	1600	3600	1700	1700	3500	3800	2200	5200	3400	
ACTINOS 14 DAY, 26°C PER mL		80148	1	0	0	3	2	2	2	1	0	2	
FUNGI PER mL		31856	0	1	0	1	0	0	0	0	0	1	

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300		00036
DIRECTION	00036	SW	W	W	W	W	W		W
VELOCITY	00035	10	8	9	9	6	6		

SURVEY BY: J. Vencill/G. Slowik/E.Bailey

REMARKS: Weather Conditions: Hazy and Foggy
Lake Conditions: Waves Calm to 1' W/Light Winds

Appendix I-7

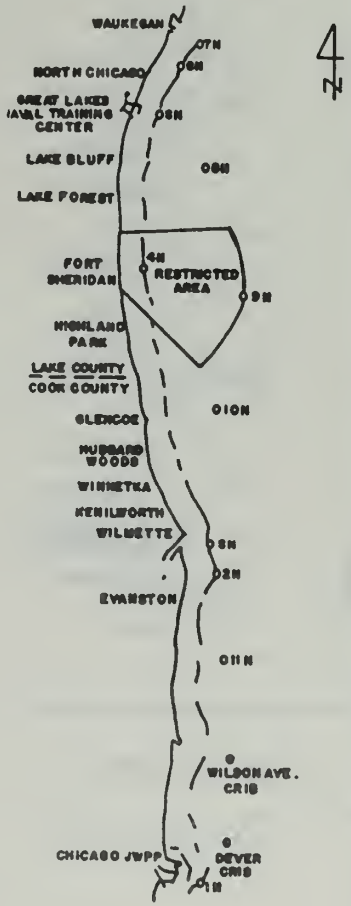
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

NORTH SHORE LAKE SURVEY

DATE June 16, 19 87



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER									
		1N CHW013	2N CHW011	3N CHW010	5N CHW005	6N CHW004	7N CHW003	8N CHW006	9N CHW008	10N CHW009	11N CHW012
TIME		0832	0933	0939	1102	1109	1118	1043	1020	1001	0913
TEMPERATURE °C	00010	19	19	19	18	19	19	18	19	19	19
TURBIDITY F.T.U.	00076	1.0	0.70	0.55	0.80	0.40	0.50	0.35	0.35	0.50	0.55
ODOR, THRESHOLD	00086	2 Df	1 DM	2 M	1M	1 M	1 M	1 M	1M	1M	1M
pH	00400	8.3	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
SULFATE mg/L	00945	18.7	19.0	19.1	19.0	19.2	19.2	19.2	19.0	19.2	19.5
CHLORIDE mg/L	00940	8.9	8.9	8.9	9.0	8.9	8.9	8.9	9.0	8.9	9.0
PHOSPHATE, TOTAL mg/L	00650	< 0.01	< 0.01	0.01	< 0.01	0.01	< 0.01	< 0.01	<0.01	0.02	< 0.01
PHOSPHATE, DISSOLVED mg/L	00653	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01
CONDUCTIVITY µ mhos	00095	285	285	290	290	290	290	290	285	285	285
RESIDUE, NONFILTRABLE mg/L	00530	2	2	1	0	0	3	0	1	1	0
OXYGEN DEMAND, CHEMICAL mg/L	00335	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
NITROGEN, AMMONIA mg/L	00610	<0.01	<0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	< 0.01	< 0.01	< 0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.20	0.20	0.21	0.22	0.22	0.22	0.22	0.22	0.21	0.22
NITROGEN, ORGANIC mg/L	00605	0.22	0.21	0.18	0.18	0.17	0.17	0.18	0.17	0.21	0.18
PHENOL-LIKE SUBSTANCES µg/L	32730	1	-	1	1	-	< 1	-	1	-	< 1
PLATE COUNT 48 hr., 35°C PER mL	31753	3	4	1	0	0	1	0	0	0	0
MF-TC PER 100mL	31503	2	0	0	0	0	2	0	0	0	0
MF-FC PER 100mL	31616	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100mL	31679	0	0	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	450	840	450	840	330	750	360	570	480	540
ACTINOS 14 DAY, 26°C PER mL	80148	2	0	1	1	1	0	0	0	1	0
FUNGI PER mL	31856	0	0	0	1	0	0	0	0	0	1

METEOROLOGICAL DATA								PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	00036
DIRECTION	00036	N	N	N	N	N	N	N
VELOCITY	00035	6	5	5	5	6	8	

SURVEY BY: S. Slowik/K.Rudmin

REMARKS Weather conditions: Sunny, some haziness
Lake conditions: North winds, Waves 1'-2'

Appendix I-8

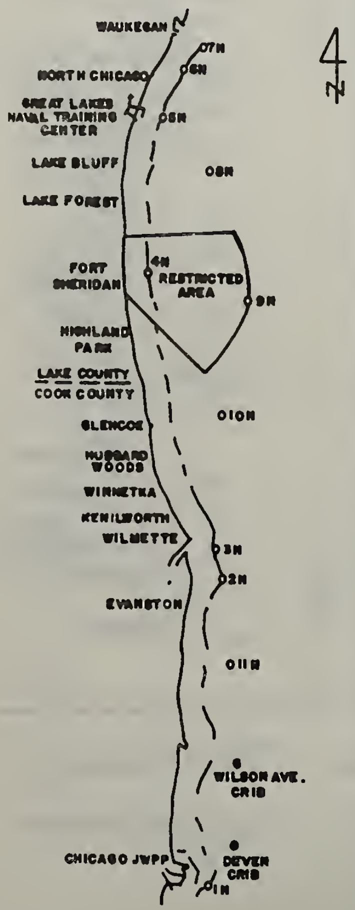
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

NORTH SHORE LAKE SURVEY

DATE August 4, 19 87



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER									
		1N CHW013	2N CHW011	3N CHW010	5N CHW005	6N CHW004	7N CHW003	8N CHW006	9N CHW008	10N CHW009	11N CHW012
TIME		0831	0931	0936	1104	1111	1120	1040	1017	0958	0913
TEMPERATURE °C	00010	24	21	21	22	21	21	25	24	23	21
TURBIDITY F.T.U.	00076	0.65	0.70	0.65	0.85	0.85	0.90	0.75	0.80	0.80	0.65
ODOR, THRESHOLD	00086	1DM	1M	1M	1DM	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.4	8.4	8.5	8.5	8.4	8.4
SULFATE mg/L	00945	21.0	20.8	20.6	20.7	20.0	19.2	19.6	19.9	19.9	20.7
CHLORIDE mg/L	00940	9.5	9.2	9.1	9.2	9.1	9.0	9.3	9.4	9.5	9.3
PHOSPHATE, TOTAL mg/L	00650	0.06	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02
PHOSPHATE, DISSOLVED mg/L	00653	0.03	0.01	0.01	0.02	0.02	<0.01	<0.01	0.02	<0.01	0.01
CONDUCTIVITY µ mhos	00095	280	290	290	290	290	290	290	290	290	290
RESIDUE, NONFILTRABLE mg/L	00530	7	6	7	6	7	6	6	6	8	6
OXYGEN DEMAND, CHEMICAL mg/L	00335	5.1	<5	<5	<5	<5	<5	7.3	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.25	0.23	0.23	0.24	0.24	0.26	0.24	0.24	0.25	0.25
NITROGEN, ORGANIC mg/L	00605	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.14	0.16	0.16
PHENOL-LIKE SUBSTANCES µg/L	32730	1	-	1	3	-	2	-	1	-	1
PLATE COUNT 48 hr., 35°C PER mL	31753	110	4	1	0	4	11	0	0	4	2
MF-TC PER 100mL	31503	14	0	0	0	0	0	0	0	0	8
MF-FC PER 100mL	31616	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	0	0	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	210	210	810	510	450	420	360	480	600	300
ACTINOS 14 DAY, 26°C PER mL	80148	0	0	0	0	1	0	0	0	0	0
FUNGI PER mL	31856	0	0	0	0	1	2	0	0	0	3

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	N	N	N	NE	NE	NE	NE	NE
VELOCITY	00035	12	9	10	10	13	19	18	

SURVEY BY: J. Vencill/K. Rudmin

REMARKS: Weather and Lake Conditions:
Clear and sunny w/increasing clouds throughout the day
Waves 1 - 2' increasing to 4' and greater by 9:30 AM.
Lake swells were moderate developing to large and heavy.

Appendix I-9

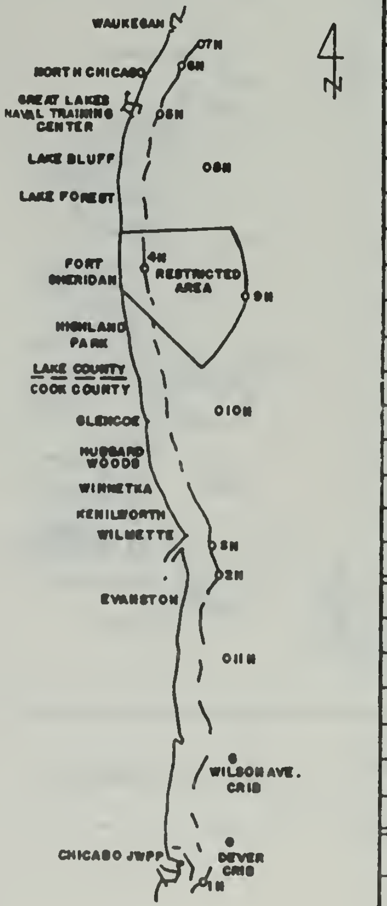
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

NORTH SHORE LAKE SURVEY

DATE September 9, 1987



PARAMETER	STORET NUMBER	1N CHW013	2N CHW011	3N CHW010	5N CHW005	6N CHW004	7N CHW003	8N CHW006	9N CHW008	10N CHW009	11N CHW012
TIME		0835	0940	0944	1107	1114	1122	1048	1025	1006	0917
TEMPERATURE °C	00010	22	21	21	21	21	21	21	21	21	21
TURBIDITY F.T.U.	00076	0.90	0.80	0.70	0.60	0.80	0.70	0.70	0.70	0.70	0.60
ODOR, THRESHOLD	00086	2M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.3	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	25.4	23.5	25.7	24.4	25.2	25.1	24.7	26.5	23.6	25.2
CHLORIDE mg/L	00940	9.4	9.4	9.4	9.4	9.4	9.4	9.3	9.4	9.4	9.4
PHOSPHATE, TOTAL mg/L	00650	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.01	0.01	0.01
PHOSPHATE, DISSOLVED mg/L	00653	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
CONDUCTIVITY µ mhos	00095	285	285	280	280	280	280	280	280	280	280
RESIDUE, NONFILTRABLE mg/L	00530	1	2	2	1	2	2	1	2	2	1
OXYGEN DEMAND, CHEMICAL mg/L	00335	7.0	<5	<5	<5	7.8	<5	5.1	<5	5.7	5.5
NITROGEN, AMMONIA mg/L	00610	<0.01	<0.01	0.01	<0.01	0.01	0.02	0.01	0.02	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.21	0.19	0.19	0.19	0.19	0.20	0.19	0.20	0.20	0.20
NITROGEN, ORGANIC mg/L	00605	0.22	0.16	0.18	0.16	0.16	0.20	0.16	0.16	0.16	0.18
PHENOL-LIKE SUBSTANCES µg/L	32730	<1	-	1	1	-	<1	-	<1	-	<1
PLATE COUNT 48 hr., 35°C PER mL	31753	69	82	45	39	46	46	24	19	51	27
MF-TC PER 100mL	31503	48	0	0	0	6	0	0	0	0	0
MF-FC PER 100mL	31616	8	0	0	0	0	0	0	0	0	0
MF-FS PER 100mL	31679	0	0	0	0	0	0	2	0	0	0
PLANKTON PER mL	60050	120	150	90	150	30	180	330	120	150	60
ACTINOS 14 DAY, 26°C PER mL	80148	0	1	0	0	0	0	0	0	0	0
FUNGI PER mL	31856	1	1	0	0	0	2	1	1	0	0

METEOROLOGICAL DATA

TIME		0800	0900	1000	1100	1200	1300	1400	PREVAILING WIND 00036
DIRECTION	00036	NE	NE	E	E	NE	E	E	E
VELOCITY	00035	4	4	7	6	7	10	10	

SURVEY BY: J. Vencill/J. Rak

REMARKS: Weather Conditions: Fog early, later clearing to partly cloudy skies. Air Temperatures in the seventies.
Lake Conditions: Waves 0-1' w/no Lake Swells

Appendix I-10

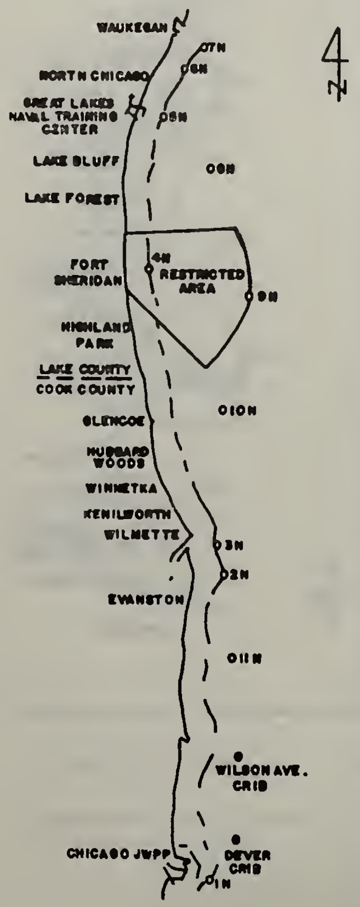
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

NORTH SHORE LAKE SURVEY

DATE October 6, 1987



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER										
		1N CHW013	2N CHW011	3N CHW010	5N CHW005	6N CHW004	7N CHW003	8N CHW006	9N CHW008	10N CHW009	11N CHW012	
TIME		0834	0933	0938	1105	1111	1121	1042	1019	1000	0914	
TEMPERATURE °C	00010	16	17	17	16	16	16	17	17	17	16	
TURBIDITY F.T.U.	00076	6.2	1.9	1.6	3.4	2.9	3.0	0.85	0.90	1.1	3.5	
ODOR, THRESHOLD	00086	2DM	1M	1M	1M	1M	1M	1M	1M	1M	1M	
pH	00400	8.3	8.3	8.4	8.4	8.4	8.3	8.4	8.4	8.4	8.4	
SULFATE mg/L	00945	22.7	22.2	22.6	21.8	22.9	22.3	22.0	21.6	21.7	21.8	
CHLORIDE mg/L	00940	9.5	9.5	9.2	9.8	9.0	9.1	9.1	8.9	8.9	9.1	
PHOSPHATE, TOTAL mg/L	00650	0.06	0.02	0.03	0.04	0.02	0.02	0.02	0.01	0.02	0.04	
PHOSPHATE, DISSOLVED mg/L	00653	0.02	0.01	0.01	0.02	<0.01	0.01	<0.01	0.01	0.01	0.01	
CONDUCTIVITY µ mhos	00095	300	285	290	300	295	305	295	300	280	285	
RESIDUE, NONFILTRABLE mg/L	00530	10	4	3	5	5	5	2	2	2	5	
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	<5	<5	<5	5.0	<5	
NITROGEN, AMMONIA mg/L	00610	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
NITROGEN, NITRITE-NITRATE mg/L	00630	0.18	0.18	0.18	0.19	0.20	0.20	0.19	0.18	0.17	0.20	
NITROGEN, ORGANIC mg/L	00605	0.22	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	
PHENOL-LIKE SUBSTANCES µg/L	32730	2	-	1	2	-	2	-	2	-	2	
PLATE COUNT 48 hr., 35°C PER mL	31753	54	20	8	22	15	51	12	9	8	44	
MF-TC PER 100 mL	31503	28	6	2	12	2	6	2	0	4	14	
MF-FC PER 100mL	31616	2	0	0	0	0	2	0	0	0	0	
MF-FS PER 100 mL	31679	0	2	0	0	0	2	2	0	0	0	
PLANKTON PER mL	60050	720	810	810	720	900	480	540	540	1500	930	
ACTINOS 14 DAY, 26°C PER mL	80148	3	1	5	3	1	2	0	1	1	1	
FUNGI PER mL	31856	0	1	0	1	2	1	0	0	1	0	

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300		00036
DIRECTION	00036	N	N	N	N	N	N		N
VELOCITY	00035	15	14	12	15	15	10		

SURVEY BY: J. Vencill/K.Rudmin

REMARKS: Weather Conditions: cloudy and cool w/the threat of rain.
Lake Conditions: 3-4' waves w/moderate to heavy lake swells.

Appendix I-11

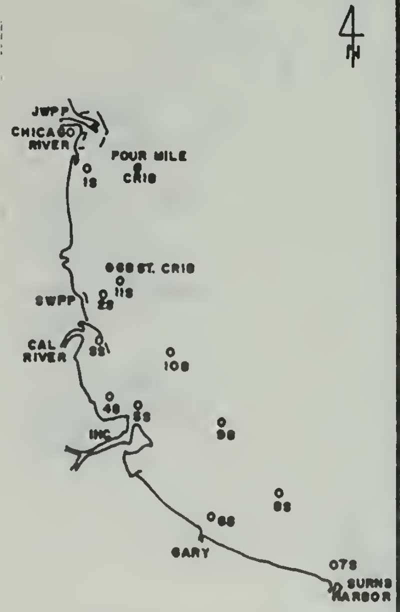
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

SOUTH SHORE LAKE SURVEY

DATE March 24, 1987



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER										
		1S	2S	3S	4S	5S	6S	7S	8S	9S	10S	11S
		CHW014	CHW015	CHW017	CHW019	CHW020	CHW021	CHW024	CHW023	CHW022	CHW018	CHW016
TIME		0842	0916	0927	0943	0952	1026	1100	1123	1146	1209	1232
TEMPERATURE °C	00010	6	6	8	7	6	6	6	6	6	6	6
TURBIDITY F.T.U.	00076	17	7.3	7.5	6.0	6.5	3.1	2.0	1.9	2.2	4.7	9.5
ODOR, THRESHOLD	00086	2DM	1M	1M	2M	1M	1M	2DM	1M	2M	1M	1M
pH	00400	8.3	8.3	8.4	8.3	8.4	8.4	8.4	8.4	8.3	8.3	8.4
SULFATE mg/L	00945	24.0	24.9	27.8	24.9	26.0	25.0	25.3	25.4	23.7	24.2	23.7
CHLORIDE mg/L	00940	9.5	11.5	15.5*	11.5	12.0	11.5	11.7	11.5	10.5	11.2	11.0
PHOSPHATE, TOTAL mg/L	00650	0.05	0.03	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.04
PHOSPHATE, DISSOLVED mg/L	00653	0.02	0.01	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03
CONDUCTIVITY µmhos	00095	310	315	335	315	325	325	335	330	315	315	310
RESIDUE, NONFILTRABLE mg/L	00530	10	9	9	5	7	6	2	2	3	4	7
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	0.03	0.07	0.06	0.04	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
NITROGEN, NITRITE-NITRATE mg/L	00630	0.32	0 35	0.43	0.35	0.38	0.39	0.47	0.45	0.35	0.35	0.34
NITROGEN, ORGANIC mg/L	00605	0.06	0.07	0.10	0.06	0.09	0.06	0.07	0.18	0.12	0.10	0.07
PHENOL-LIKE SUBSTANCES µg/L	32730	<1	<1	<1	4**	<1	<1	2	<1	<1	<1	<1
PLATE COUNT 48 hr., 35°C PER mL	31753	19	83	530	780	440	210	24	210	4	3	42
MF-TC PER 100mL	31503	0	0	0	4	0	0	4	0	0	0	0
MF-FC PER 100mL	31616	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100mL	31679	0	2	4	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	390	330	270	450	1000	780	1900	1100	750	570	960
ACTINOS 14 DAY, 26°C PER mL	80148	4	3	2	4	3	3	5	4	3	2	1
FUNGI PER mL	31856	0	0	0	0	2	0	1	1	0	0	0

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SE	SE	SE	SE	SE	SE	SE	SE
VELOCITY	00038	5	4	4	5	4	7	7	

SURVEY BY: J. Vencill/ K. Rudmin/ J. Rak

REMARKS: Cloudy w/wave 2-3' with small swells

* Checked
** Verified

Appendix I-12

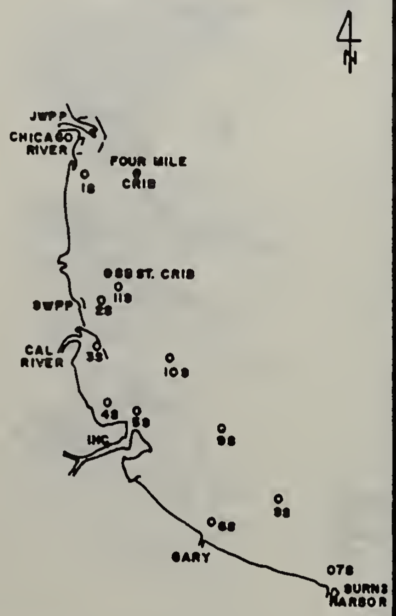
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

SOUTH SHORE LAKE SURVEY

DATE May 6, 19 87



PARAMETER	STORET NUMBER	1S CHW014	2S CHW015	3S CHW017	4S CHW019	5S CHW020	6S CHW021	7S CHW024	8S CHW023	9S CHW022	10S CHW018	11S CHW016
		SAMPLING POINT AND STATION NUMBER										
TIME		0858	0930	0944	1000	1009	1044	1116	1139	1202	1225	1248
TEMPERATURE °C	00010	12	12	13	14	13	12	13	12	11	12	13
TURBIDITY F.T.U.	00076	3.0	3.6	3.2	3.4	3.4	3.1	2.4	2.5	1.5	2.9	3.1
ODOR, THRESHOLD	00086	1 DM	1M	1 DM	1 DM	1M	1M	1M	1M	1M	1M	1DM
pH	00400	8.3	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	17.8	18.1	18.7	20.8	20.8	19.3	20.9	20.0	19.1	18.9	19.0
CHLORIDE mg/L	00940	12.5	10.8	11.0	10.7	9.7	9.7	9.8	10.5	9.6	9.5	9.5
PHOSPHATE, TOTAL mg/L	00650	0.05	0.03	0.03	0.04	0.04	0.04	0.03	0.04	< 0.01	0.03	0.02
PHOSPHATE, DISSOLVED mg/L	00653	< 0.01	<0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
CONDUCTIVITY µ mhos	00095	280	290	295	305	300	295	295	285	295	285	285
RESIDUE, NONFILTRABLE mg/L	00530	2	6	1	4	2	2	4	2	4	2	3
OXYGEN DEMAND, CHEMICAL mg/L	00335	< 5	< 5	< 5	< 5	< 5	< 5	< 5	<5	< 5	< 5	< 5
NITROGEN, AMMONIA mg/L	00610	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.17	0.19	0.22	0.26	0.30	0.24	0.25	0.24	0.20	0.20	0.20
NITROGEN, ORGANIC mg/L	00605	0.14	0.18	0.17	0.18	0.21	0.17	0.17	0.17	0.17	0.17	0.17
PHENOL-LIKE SUBSTANCES µg/L	32730	6*	<1	< 1	< 1	< 1	< 1	9*	< 1	< 1	< 1	< 1
PLATE COUNT 48 hr., 35°C PER mL	31753	7	6	9	67	63	8	380	38	2	4	5
MF-TC PER 100mL	31503	0	0	0	0	2	0	0	0	0	0	0
MF-FC PER 100mL	31616	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100mL	31679	0	0	0	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	240	690	810	1080	300	900	90	570	1950	930	420
ACTINOS 14 DAY, 26°C PER mL	80148	1	3	4	4	2	4	3	4	4	4	3
FUNGI PER mL	31856	1	0	0	1	1	0	1	0	0	0	0

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	W	W	NW	NW	N	SE	SE	W
VELOCITY	00038	3	10	6	8	5	10	10	

SURVEY BY: A.Agrawal/K.Rudmin/J.Rak

REMARKS: Sunny-Slight haze, West Southwest winds (Light) waves 1' Diminishing to calm.

*Not Checked

Appendix I-13

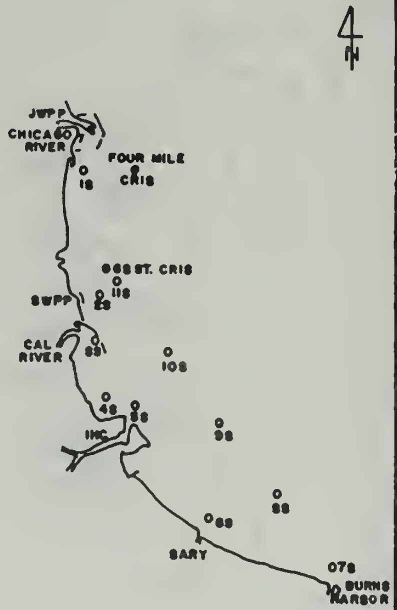
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

SOUTH SHORE LAKE SURVEY

DATE June 10, 1987



PARAMETER		STORET NUMBER	SAMPLING POINT AND STATION NUMBER										
			1S	2S	3S	4S	5S	6S	7S	8S	9S	10S	11S
			CHW014	CHW015	CHW017	CHW019	CHW020	CHW021	CHW024	CHW023	CHW022	CHW018	CHW016
TIME			0856	0931	0943	0958	1007	1041	1115	1138	1201	1224	1247
TEMPERATURE	°C	00010	15	17	17	20	20	18	18	18	18	18	18
TURBIDITY	F.T.U.	00076	1.2	1.5	1.6	2.5	2.0	1.4	2.4	0.65	0.45	0.70	0.60
ODOR, THRESHOLD		00086	2 Df	1 Df	1 DM	1M	1M	1M	1M	1M	1M	1M	1M
pH		00400	8.3	8.4	8.5	8.5	8.3	8.5	8.5	8.5	8.5	8.5	8.5
SULFATE	mg/L	00945	17.9	18.5	18.5	19.6	24.4	18.6	18.9	18.7	18.4	18.2	18.3
CHLORIDE	mg/L	00940	8.7	8.8	9.0	10.0	14.2	9.0	9.2	9.1	9.1	9.0	8.8
PHOSPHATE, TOTAL	mg/L	00650	0.05	< 0.01	< 0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	<0.01	< 0.01	<0.01
PHOSPHATE, DISSOLVED	mg/L	00653	0.01	< 0.01	< 0.01	<0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	< 0.01	<0.01
CONDUCTIVITY	μ mhos	00095	280	290	290	300	350	295	290	285	280	280	275
RESIDUE, NONFILTRABLE	mg/L	00530	2	1	2	5	4	2	4	0	0	1	1
OXYGEN DEMAND, CHEMICAL	mg/L	00335	<5	5.7	< 5	< 5	5.1	< 5	9.4	6.2	< 5	< 5	8.1
NITROGEN, AMMONIA	mg/L	00610	0.01	0.02	0.01	0.02	0.32 *	0.01	0.02	0.02	0.02	0.02	0.02
NITROGEN, NITRITE-NITRATE	mg/L	00630	0.21	0.23	0.22	0.26	0.52	0.23	0.25	0.24	0.25	0.24	0.23
NITROGEN, ORGANIC	mg/L	00605	0.16	0.16	0.16	0.18	0.20	0.18	0.18	0.18	0.16	0.16	0.16
PHENOL-LIKE SUBSTANCES	μg/L	32730	1	1	< 1	< 1	1	1	1	< 1	< 1	< 1	1
PLATE COUNT 48 hr., 35°C PER mL		31753	8	10	39	6400	29000	16	1200	84	34	6	2
MF-TC PER 100mL		31503	0	0	4	78	144	4	168	0	0	0	0
MF-FC PER 100mL		31616	0	0	0	10	34	0	44	0	0	0	0
MF-FS PER 100mL		31679	0	0	0	0	0	0	0	0	0	0	0
PLANKTON PER mL		60050	990	1100	2400	1000	720	480	630	840	120	1100	360
ACTINOS 14 DAY, 26°C PER mL		80148	0	1	0	0	0	2	6	1	1	1	1
FUNGI PER mL		31856	0	0	0	0	0	0	3	0	0	0	0

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SE	SE	SE	SE	SE	E	E	SE
VELOCITY	00035	9	8	8	7	6	10	10	

SURVEY BY: G.Slowik/K.Rudmin

REMARKS: Lake Conditions: Waves 1' - 2', Swells, E-SE winds
Weather conditions: Sunny, turning partly cloudy.

*Verified W/Lab

Appendix I-14

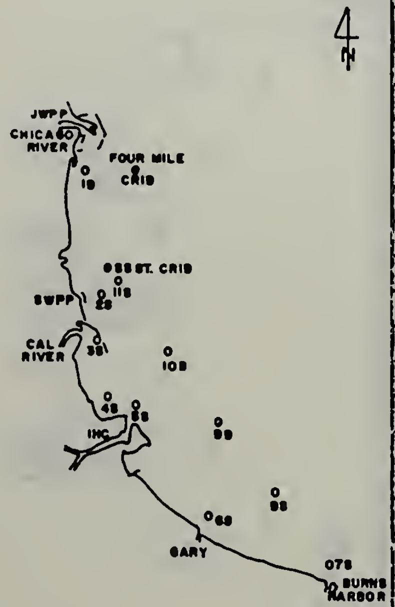
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

SOUTH SHORE LAKE SURVEY

DATE July 7, 1987



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER										
		1S	2S	3S	4S	5S	6S	7S	8S	9S	10S	11S
		CHW014	CHW015	CHW017	CHW019	CHW020	CHW021	CHW024	CHW023	CHW022	CHW018	CHW016
TIME		0847	0926	0937	0953	1002	1036	1110	1133	1156	1219	1242
TEMPERATURE °C	00010	23	22	23	23	23	23	23	23	23	23	23
TURBIDITY F.T.U.	00076	0.90	0.70	1.8	0.65	0.65	0.35	0.50	0.40	0.40	0.50	0.45
ODOR, THRESHOLD	00086	2G	2M	20M	1DM	1DM	10M	1DM	1DM	1M	1M	1DM
pH	00400	8.4	8.5	8.4	8.5	8.4	8.5	8.5	8.5	8.5	8.5	8.5
SULFATE mg/L	00945	20.7	20.7	21.4	21.6	21.8	20.7	21.0	21.2	21.1	21.1	21.4
CHLORIDE mg/L	00940	9.5	9.6	9.5	10.0	10.0	9.1	9.5	9.3	9.8	9.7	9.2
PHOSPHATE, TOTAL mg/L	00650	0.05	0.02	0.03	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.01
PHOSPHATE, DISSOLVED mg/L	00653	0.02	0.02	0.01	0.01	0.01	0.01	0.03	0.01	<0.01	<0.01	<0.01
CONDUCTIVITY μ mhos	00095	290	290	290	290	290	285	285	285	285	285	285
RESIDUE, NONFILTRABLE mg/L	00530	2	2	3	4	2	1	2	2	1	2	2
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	<5	<5	12.6	<5	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	<0.01	0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.22	0.23	0.24	0.26	0.28	0.25	0.27	0.27	0.26	0.27	0.26
NITROGEN, ORGANIC mg/L	00605	0.19	0.19	0.15	0.19	0.15	0.15	0.19	0.19	0.15	0.19	0.15
PHENOL-LIKE SUBSTANCES μg/L	32730	<1	<1	<1	<1	<1	3	1	1	<1	1	<1
PLATE COUNT 48 hr., 35°C PER mL	31753	4	15	47	110	480	53	14	2	7	42	8
MF-TC PER 100mL	31503	0	4	20	12	16	0	4	0	0	0	0
MF-FC PER 100mL	31616	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100mL	31679	0	0	2	0	0	0	0	0	0	0	0
PLANKTON PER mL	60050	0	60	30	30	30	0	0	30	0	30	60
ACTINOS 14 DAY, 26°C PER mL	80148	0	0	1	1	0	0	0	0	0	1	0
FUNGI PER mL	31856	0	1	1	1	1	2	2	0	0	1	2

METEOROLOGICAL DATA									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SW	SW	SW	SW	SW	W	W	SW
VELOCITY	00035	14	15	13	12	11	8	10	

SURVEY BY: G. Slowik/K.Rudmin

REMARKS:
Lake Condition: SW winds. Waves 1' to 2'.
Weather Condition: Sunny & Hazy some clouds.
Additional Remarks: Stopped at 68th St. Crib prior to Point 2S to drop off cribkeeper.

Appendix I-15

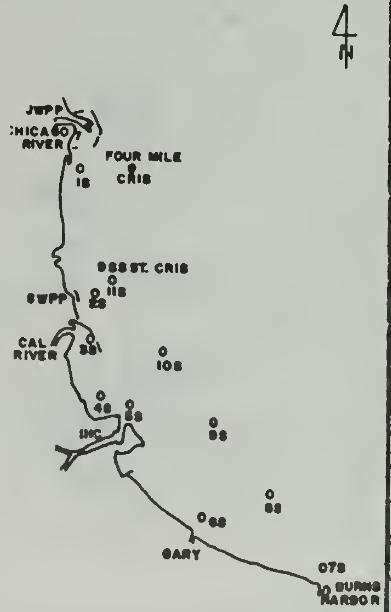
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

SOUTH SHORE LAKE SURVEY

DATE August 25, 1987



PARAMETER	STORET NUMBER	1S CHW014	2S CHW015	3S CHW017	4S CHW019	5S CHW020	6S CHW021	7S CHW024	8S CHW023	9S CHW022	10S CHW018	11S CHW016
		SAMPLING POINT AND STATION NUMBER										
TIME		0834	0912	0923	0936	0948	1027	1059	1122	1145	1208	1231
TEMPERATURE °C	00010	21	21	21	21	21	21	21	21	21	20	21
TURBIDITY F.T.U.	00076	0.85	0.85	1.8	2.0	1.9	1.5	1.3	0.75	0.80	0.80	0.70
ODOR, THRESHOLD	00086	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.5	8.5	8.5
SULFATE mg/L	00945	21.9	22.7	23.6	24.8	24.3	24.3	23.6	22.8	23.6	23.8	23.1
CHLORIDE mg/L	00940	8.9	9.0	9.1	9.4	9.4	9.5	9.2	9.0	9.0	9.0	9.0
PHOSPHATE, TOTAL mg/L	00650	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
PHOSPHATE, DISSOLVED mg/L	00653	0.02	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
CONDUCTIVITY μ mhos	00095	285	285	290	290	295	290	285	285	290	285	300
RESIDUE, NONFILTRABLE mg/L	00530	2	2	4	1	2	4	3	3	3	2	2
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	5.4	<5	<5	<5	<5	<5	6.1	5.0	<5
NITROGEN, AMMONIA mg/L	00610	<0.01	<0.01	<0.01	0.02	<0.01	0.02	<0.01	0.02	0.01	<0.01	<0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.23	0.23	0.24	0.24	0.26	0.27	0.26	0.25	0.26	0.27	0.25
NITROGEN, ORGANIC mg/L	00605	0.12	0.12	0.12	0.16	0.12	0.16	0.12	0.12	0.12	0.12	0.12
PHENOL-LIKE SUBSTANCES μg/L	32730	2	<1	<1	<1	<1	1	<1	<1	<1	1	<1
PLATE COUNT 48 hr., 35°C PER mL	31753	5	6	92	490	220	320	290	17	43	14	10
MF-TC PER 100mL	31503	2	0	2	14	6	12	6	2	2	2	2
MF-FC PER 100mL	31616	0	0	4	4	4	0	2	0	0	0	0
MF-FS PER 100mL	31679	0	0	4	0	2	0	0	0	8	0	0
PLANKTON PER mL	60050	300	180	510	150	60	1300	150	510	180	30	30
ACTINOS 14 DAY, 26°C PER mL	80148	0	0	0	0	0	0	0	0	0	0	1
FUNGI PER mL	31856	0	0	0	1	0	0	0	1	0	0	0

METEOROLOGICAL DATA								PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	00036
DIRECTION	00036	W	SW	SW	W	W	SW	SW
VELOCITY	00035	5	5	8	12	10	6	

SURVEY BY: J. Vencill/ K. Rudmin

REMARKS: Weather Conditions: Cloudy with intermittent showers -
Air temperature in the upper sixties.
Lake Conditions: Light winds w/waves 1-2'
No lake swells

Appendix I-16

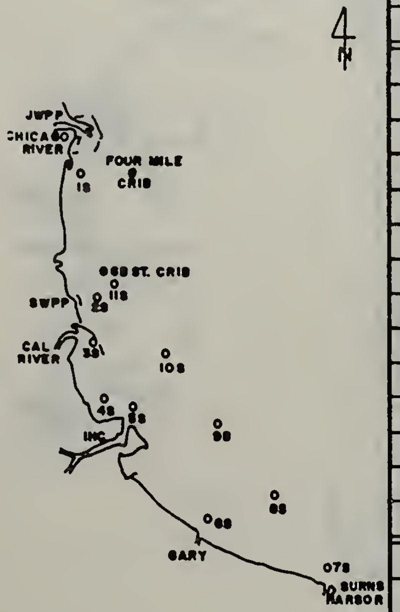
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

SOUTH SHORE LAKE SURVEY

DATE September 16, 1987



PARAMETER	STORET NUMBER	1S CHW014	2S CHW015	3S CHW017	4S CHW019	5S CHW020	6S CHW021	7S CHW024	8S CHW023	9S CHW022	10S CHW018	11S CHW016
		SAMPLING POINT AND STATION NUMBER										
TIME		0844	0922	0934	0952	0958	1036	1111	1134	1157	1220	1243
TEMPERATURE °C	00010	22	22	22	22	22	21	21	21	21	21	21
TURBIDITY F.T.U.	00076	0.90	0.70	0.95	0.60	0.55	0.55	0.70	0.50	0.50	0.50	0.60
ODOR, THRESHOLD	00086	1G	1G	1Df	1G	1G	1G	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.5	8.4	8.5	8.5	8.5	8.5	8.5	8.5	8.5
SULFATE mg/L	00945	23.7	24.8	26.3	26.0	26.2	24.5	25.7	23.6	23.6	23.8	24.5
CHLORIDE mg/L	00940	9.5	9.4	10.3	10.5	11.2	9.5	10.3	9.2	9.2	9.6	9.6
PHOSPHATE, TOTAL mg/L	00650	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
PHOSPHATE, DISSOLVED mg/L	00653	0.01	0.01	0.02	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01
CONDUCTIVITY µ mhos	00095	290	295	300	300	300	290	295	285	280	285	285
RESIDUE, NONFILTRABLE mg/L	00530	1	1	3	1	2	1	1	1	2	1	1
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	13.8	11.5	<5	<5	9.1	<5	<5	<5	<5
NITROGEN, AMMONIA mg/L	00610	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.03	<0.01	<0.01	<0.01	<0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.20	0.22	0.24	0.25	0.25	0.20	0.21	0.17	0.16	0.19	0.21
NITROGEN, ORGANIC mg/L	00605	0.14	0.14	0.14	0.14	0.16	0.14	0.14	0.14	0.14	0.14	0.14
PHENOL-LIKE SUBSTANCES µg/L	32730	2	2	1	1	1	1	1	1	1	1	2
PLATE COUNT 48 hr., 35°C PER mL	31753	120	240	330	3000	5100	1800	18000	45	13	92	140
MF-TC PER 100mL	31503	14	44	22	18	12	18	48	4	0	12	4
MF-FC PER 100mL	31616	2	36	12	6	0	4	6	0	0	0	0
MF-FS PER 100mL	31679	0	4	8	0	0	2	2	0	0	0	0
PLANKTON PER mL	60050	150	450	120	300	60	570	840	180	450	270	180
ACTINOS 14 DAY, 26°C PER mL	80148	0	0	1	0	0	0	3	0	0	0	0
FUNGI PER mL	31856	1	0	1	0	0	1	2	0	0	1	1

METEOROLOGICAL DATA

									PREVAILING WIND
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SW	SW	SW	S	S	SW		SW
VELOCITY	00038	10	6	8	10	10	10		

SURVEY BY: J. Vencill/K. Rudmin

REMARKS: Lake Conditions: 1 - 3' Waves, small lake swells.
Weather Conditions: Cloudy, rainy and foggy.

Appendix I-17

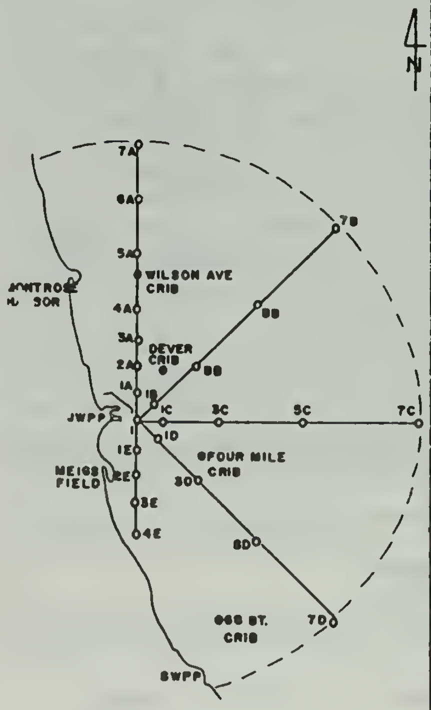
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

J.W.P.P. RADIAL LAKE SURVEY

DATE May 13, 1987



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER																						
		1A	2A	3A	4A	* 5A	6A	7A	1B	3B	*5B	7B	1C	3C	*5C	7C	1D	3D	*5D	7D	1E	2E	3E	*4E
		CHW052	CHW047	CHW042	CHW037	CHW033	CHW029	CHW025	CHW053	CHW043	CHW034	CHW026	CHW054	CWH044	CHW035	CHW027	CHW055	CHW045	CHW036	CHW028	CHW056	CHW051	CHW046	CHW041
TIME		0857	0901	0906	0910	0919	0928	0937	1053	1044	1030	1012	1107	1116	1130	1148	1304	1255	1241	1223	1309	1314	1319	1324
TEMPERATURE °C	00010	13	13	12	12	13	13	12	13	13	12	9	13	13	12	11	13	13	13	13	13	13	13	13
TURBIDITY F.T.U.	00076	1.5	1.5	1.4	1.5	1.4	1.6	1.6	1.2	1.3	1.0	1.0	1.2	1.2	1.1	1.0	1.6	1.3	1.2	1.3	2.1	1.5	1.7	1.8
ODOR. THRESHOLD	00086	1DM	1Df	1M	1M	1M	1M	1Df	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	19.9	20.4	20.3	20.6	20.8	21.8	21.4	21.0	21.0	21.3	21.2	21.8	22.1	22.0	21.9	22.2	22.4	22.6	22.3	22.7	22.8	22.8	22.6
CHLORIDE mg/L	00940	9.3	9.3	9.3	9.4	9.3	9.4	9.5	9.2	9.0	9.1	8.9	9.0	9.0	9.0	9.0	9.0	9.0	9.3	9.0	9.0	9.3	9.3	9.0
PHOSPHATE, TOTAL mg/L	00650	0.03	0.01	0.04	<.01	<.01	<.01	0.01	0.01	<.01	0.01	0.02	<.01	<.01	0.01	0.01	0.01	<.01	0.01	0.01	0.01	0.01	0.02	0.02
PHOSPHATE, DISSOLVED mg/L	00653	0.03	<.01	<.01	<.01	<.01	<.01	<.01	0.01	<.01	<.01	<.01	<.01	<.01	0.01	0.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
CONDUCTIVITY µ mhos	00095	290	290	290	290	290	290	295	290	290	290	290	290	290	290	290	285	290	290	290	290	290	290	290
RESIDUE, NONFILTRABLE mg/L	00530	6	6	4	4	5	6	5	5	4	5	6	4	3	4	4	4	4	3	3	5	4	6	4
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	5.4	<5	<5	<5	<5	7.0	<5	<5	6.9	<5	<5	5.8	<5	5.3	8.3	6.3	<5	** 21.3	7.3
NITROGEN, AMMONIA mg/L	00610	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.05	0.04	0.05	0.04	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NITROGEN, NITRITE-NITRATE mg/L	00630	0.23	0.23	0.24	0.24	0.25	0.25	0.26	0.23	0.23	0.25	0.24	0.23	0.23	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
NITROGEN ORGANIC mg/L	00605	0.16	0.16	0.15	0.15	0.16	0.16	0.28	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.24	0.24	0.20
IRON, TOTAL µg/L	01045	13	18	<10	<10	39	38	10	<10	12	<10	<10	19	<10	19	89	23	<10	<10	14	76	10	38	24
PHENOL-LIKE SUBSTANCES µg/L	32730	-	-	-	-	1	-	-	-	-	3	-	-	-	<1	-	-	-	2	-	-	-	-	<1
PLATE COUNT 48hr., 35°C PER mL	31753	12	4	2	1	6	1	1	1	3	2	4	3	0	4	2	3	2	0	2	2	1	2	2
MF-TC PER 100 mL	31503	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANKTON PER mL	60050	660	-	1400	-	510	-	630	1200	1400	720	2100	1300	1100	990	720	2800	1000	570	840	3000	-	3800	-
ACTINOS 14 DAY, 26°C PER mL	80148	1	4	2	4	2	4	3	0	2	2	2	1	1	2	2	0	0	2	1	1	2	1	1
FUNGI PER mL	31856	1	1	1	1	1	2	1	1	1	0	1	1	1	1	1	0	0	1	0	1	1	1	0

METEOROLOGICAL DATA								PREVAILING WINDS
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	S	SE	SE	SE	SE	NE	NE	SE
VELOCITY	00035	10	8	9	7	5	4	4	

SURVEY BY: J. Vencill/J. Rak

REMARKS:
Weather and Lake conditions: Sunny and clear, small to moderate lake swells w/waves 2-4'
* Split samples with IEPA ** Confirmed

Appendix I-18

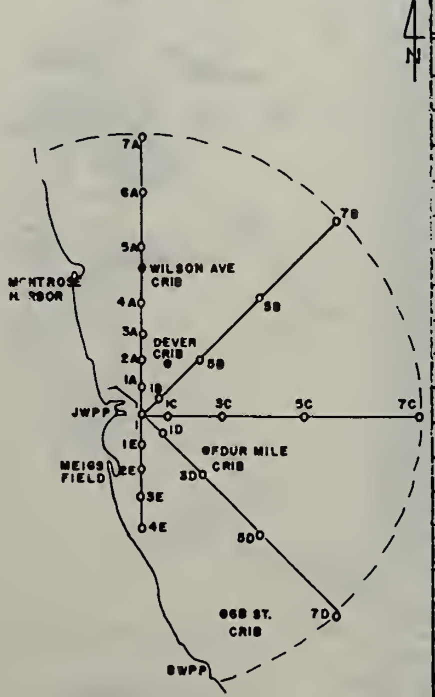
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

J.W.P.P. RADIAL LAKE SURVEY

DATE July 28, 19 87



PARAMETER	STORET NUMBER	1A CHW052	2A CHW047	3A CHW042	4A CHW037	5A CHW033	6A CHW029	7A CHW025	1B CHW063	3B CHW043	5B CHW034	7B CHW026	1C CHW054	3C CWH044	5C CHW035	7C CHW027	1D CHW055	3D CHW045	5D CHW036	7D CHW028	1E CHW056	2E CHW051	3E CHW046	4E CHW041
TIME		0839	0844	0848	0853	0902	0911	0920	1038	1029	1015	0957	1055	1104	1118	1136	1252	1243	1229	1211	1259	1304	1309	1314
TEMPERATURE °C	00010	24	24	24	24	24	24	23	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	24
TURBIDITY F.T.U.	00076	0.80	0.80	0.90	0.75	0.85	0.85	0.70	0.85	0.90	0.90	0.90	0.80	1.00	0.85	0.75	0.85	0.80	0.95	0.90	0.90	0.75	1.00	1.00
ODOR, THRESHOLD	00086	1G	1G	1G	1G	1E	1G	1G	1G	1G	1G	1G	1M	1G	1G	1G	1M	1G	1G	1M	1DM	1M	1M	1G
pH	00400	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
SULFATE mg/L	00945	20.0	20.3	20.3	20.3	20.4	20.4	20.4	20.3	20.4	20.5	20.4	19.5	19.9	20.1	19.9	19.7	19.8	20.0	20.2	19.8	20.0	19.8	19.8
CHLORIDE mg/L	00940	9.2	9.2	9.4	9.4	9.4	9.4	9.4	9.2	9.1	9.4	9.4	9.4	9.4	9.2	10.4	9.4	9.0	9.1	9.1	9.2	9.4	9.4	9.4
PHOSPHATE, TOTAL mg/L	00650	0.07	0.02	0.02	0.01	0.04	0.01	0.02	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.05	0.02	0.01	0.01
PHOSPHATE, DISSOLVED mg/L	00653	<.01	0.01	0.01	0.01	0.01	0.01	<.01	0.02	<.01	<.01	0.02	<.01	<.01	<.01	<.01	0.02	<.01	<.01	0.01	0.01	0.01	<.01	<.01
CONDUCTIVITY µ mhos	00095	275	270	280	280	270	270	275	270	275	290	270	270	280	275	280	280	285	285	275	280	275	280	280
RESIDUE, NONFILTRABLE mg/L	00530	5	5	4	3	2	1	2	0	0	1	2	2	1	2	1	2	1	1	1	0	1	0	1
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	5.5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10.0	8.0	6.4	6.5
NITROGEN, AMMONIA mg/L	00610	0.02	0.01	<.01	0.02	0.01	0.01	<.01	0.02	0.02	<.01	0.01	0.01	<.01	0.01	<.01	<.01	<.01	<.01	<.01	0.01	0.02	0.01	<.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.28	0.28	0.28	0.29	0.29	0.31	0.30	0.30	0.29	0.29	0.30	0.23	0.22	0.23	0.23	0.24	0.24	0.24	0.23	0.26	0.27	0.29	0.29
NITROGEN ORGANIC mg/L	00605	0.14	0.14	0.14	0.14	0.14	0.16	0.14	0.14	0.14	0.14	0.14	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.10	0.14
IRON, TOTAL µg/L	01045	18	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
PHENOL-LIKE SUBSTANCES µg/L	32730	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
PLATE COUNT 48hr., 35°C PER mL	31753	6000	4800	8400	2400	2100	14000	1200	1000	12	8	4	2	1	0	6	5	3	4	6	7	12	6	12
MF-TC PER 100 mL	31503	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0
MF-FC PER 100 mL	31616	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANKTON PER mL	60050	120	-	0	-	30	-	0	0	0	0	30	30	30	0	0	30	30	0	30	0	-	30	-
ACTINOS 14 DAY, 20°C PER mL	80148	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
FUNGI PER mL	31856	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0

METEOROLOGICAL DATA

									PREVAILING WINDS
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SE	S	SE	SE	S	SW	S	SE
VELOCITY	00035	9	4	8	7	6	4	8	

SURVEY BY: J. Vencill/J.Rak

REMARKS: Weather and Lake Conditions
Partly cloudy w/some Haze Waves 2' w/small to moderate lake swells
No split samples with IEPA
* Plate count 1A thru 1B checked

Appendix I-19

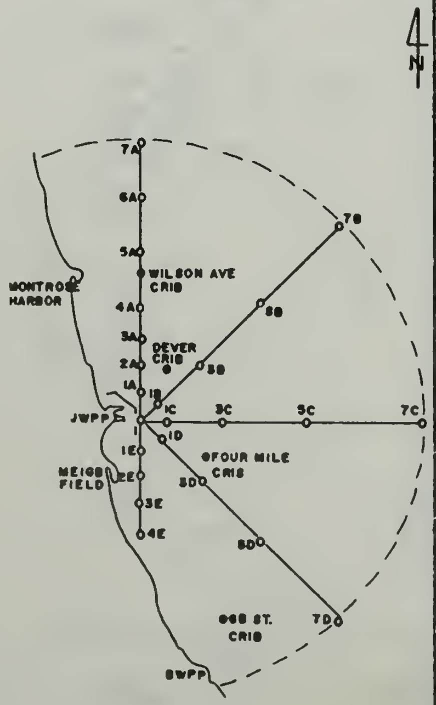
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

J.W.P.P. RADIAL LAKE SURVEY

DATE November 4, 1987



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER																						
		1A	2A	3A	4A	5A	6A	7A	1B	3B	5B	7B	1C	3C	5C	7C	1D	3D	5D	7D	1E	2E	3E	4E
		CHW052	CHW047	CHW042	CHW037	CHW033	CHW029	CHW025	CHW063	CHW043	CHW054	CHW026	CHW064	CHW044	CHW035	CHW027	CHW055	CHW045	CHW036	CHW028	CHW066	CHW051	CHW046	CHW041
TIME		0847	0851	0856	0900	0908	0917	0926	1046	1037	1023	1005	1100	1109	1123	1141	1257	1248	1234	1216	1306	1309	1313	1317
TEMPERATURE °C	00010	14	13	13	13	13	13	13	14	14	14	14	14	14	14	14	13	13	14	14	13	13	13	13
TURBIDITY F.T.U.	00076	1.3	0.95	0.85	0.70	0.50	0.45	0.45	0.70	0.40	0.40	0.25	0.75	0.45	0.40	0.30	0.70	0.55	0.50	0.55	0.70	0.75	0.75	0.65
ODOR, THRESHOLD	00086	2Df	1Df	1Df	1DM	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
SULFATE mg/L	00945	23.3	23.3	24.2	23.3	22.6	22.3	22.3	22.8	22.5	22.6	21.8	22.8	22.0	22.0	21.7	22.6	22.6	22.6	23.3	22.6	22.6	23.7	22.8
CHLORIDE mg/L	00940	9.1	9.1	9.1	8.8	9.5	9.3	9.2	9.9	8.9	8.6	8.6	9.2	9.3	9.5	8.8	8.6	9.2	8.8	9.2	9.8	9.1	9.2	9.1
PHOSPHATE, TOTAL mg/L	00650	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.02	0.01	<.01	0.02
PHOSPHATE, DISSOLVED mg/L	00653	0.02	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	0.01	<.01	<.01	<.01	0.01	0.01	<.01	<.01
CONDUCTIVITY μ mhos	00095	285	290	290	290	285	285	285	290	285	280	285	285	285	285	285	285	285	285	275	290	275	285	275
RESIDUE, NONFILTRABLE mg/L	00530	1	0	3	1	2	5	2	4	2	0	2	0	1	1	2	3	0	2	2	3	2	1	3
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	11.4	9.6	<5	<5	<5	<5	7.0	<5	<5	<5	8.8	<5	<5	6.0	<5	<5	<5	5.4	16.3	9.2
NITROGEN, AMMONIA mg/L	00610	0.01	<.01	<.01	0.04	<.01	<.01	<.01	<.01	<.01	<.01	0.01	0.02	<.01	0.01	0.02	<.01	0.02	0.01	0.01	0.03	0.03	0.01	<.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.20	0.20	0.22	0.19	0.17	0.17	0.17	0.20	0.16	0.16	0.19	0.19	0.17	0.19	0.18	0.17	0.17	0.17	0.20	0.17	0.17	0.19	0.19
NITROGEN ORGANIC mg/L	00605	0.20	0.22	0.22	0.22	0.20	0.20	0.20	0.22	0.20	0.20	0.20	0.22	0.20	0.20	0.24	0.28	0.20	0.24	0.20	0.24	0.20	0.24	0.24
IRON, TOTAL μg/L	01045	62	59	15	25	<10	35	43	41	<10	21	12	28	<10	18	<10	14	<10	<10	30	<10	<10	14	21
PHENOL-LIKE SUBSTANCES μg/L	32730	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLATE COUNT 48hr., 35°C PER mL	31753	36	48	40	12	6	4	3	30	1	2	2	32	4	0	0	3	0	10	0	9	20	2	15
MF-TC PER 100 mL	31503	12	2	0	6	0	2	6	6	2	0	0	6	0	0	2	6	2	0	0	2	6	2	2
MF-FC PER 100 mL	31616	4	2	0	2	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANKTON PER mL	60050	1680	-	1140	-	3300	-	180	2310	660	510	150	2430	900	660	780	1500	930	1740	810	1500	-	2310	-
ACTINOS 14 DAY, 20°C PER mL	80148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FUNGI PER mL	31856	1	0	0	0	1	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0

METEOROLOGICAL DATA									PREVAILING WINDS
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	NW	NW	NW	NW	NW	NW	NW	

SURVEY BY: J. Vencill/F. Schultz

REMARKS: Weather Conditions: Sunny and mild air temperatures
Lake Conditions: Breezy north westerly winds

Appendix I-20

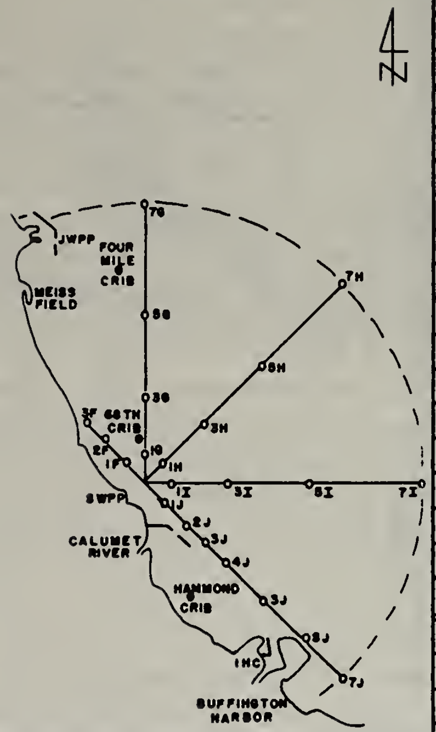
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

S.W.P.P. RADIAL LAKE SURVEY

DATE May 27., 19 87



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER																					
		1F	2F	3F*	1G	3G	*5G	7G	1H	3H	*5H	7H	1I	3I	*5I	7I	1J	2J	3J	4J	*5J	6J	7J
		CHW083	CHW078	CHW073	CHW084	CHW074	CHW065	CHW057	CHW085	CHW075	CHW066	CHW058	CHW086	CHW076	CHW067	CHW059	CHW087	CHW082	CHW077	CHW072	CHW068	CHW064	CHW060
TIME		1145	1149	1153	0939	0930	0916	0858	1210	1219	1233	1251	0953	1002	1016	1034	1140	1136	1131	1127	1118	1109	1100
TEMPERATURE °C	00010	17	17	17	17	17	17	16	17	17	17	16	17	17	17	17	17	17	17	18	18	18	17
TURBIDITY F.T.U.	00076	0.65	0.80	0.80	0.75	0.70	0.60	0.70	0.75	0.60	0.55	0.65	0.70	0.50	0.55	0.50	0.70	0.80	0.70	0.70	0.65	0.65	0.60
ODOR, THRESHOLD	00086	1 Of	1 Of	1 DM	1 Of	1 OM	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	2M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.5	8.5	8.6	8.5	8.5	8.5	8.6	8.6	8.6	8.6	8.6	8.5	8.5	8.6	8.6	8.6	8.6	8.6	8.6	8.5	8.6
SULFATE mg/L	00945	19.1	19.7	19.8	19.7	19.9	19.6	20.1	20.1	20.1	20.1	19.8	20.4	20.2	20.6	20.3	20.6	20.8	20.7	21.1	21.0	21.1	20.8
CHLORIDE mg/L	00940	9.3	9.4	9.5	9.4	9.3	9.4	9.6	9.5	9.0	9.6	9.4	9.4	9.1	9.2	9.3	9.3	9.6	9.6	9.9	9.9	10.0	9.6
PHOSPHATE, TOTAL mg/L	00650	0.05	0.02	0.01	0.01	0.01	0.01	0.01	<01	0.01	0.02	0.01	0.01	0.01	<.01	<.01	0.03	0.01	0.01	0.01	0.01	<.01	0.01
PHOSPHATE, DISSOLVED mg/L	00653	0.02	0.01	<.01	0.01	<.01	0.01	<.01	<.01	<.01	0.01	<.01	<.01	0.01	<.01	<.01	0.01	0.01	<.01	<.01	<.01	<.01	<.01
CONDUCTIVITY µ mhos	00095	285	280	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285
RESIDUE, NONFILTRABLE mg/L	00530	2	1	2	2	2	2	1	3	2	0	2	2	2	2	2	0	1	2	0	2	2	1
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	<5	<5	<5	< 5	<5	<5	<5	< 5	<5	< 5	<5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
NITROGEN, AMMONIA mg/L	00610	0.20	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.22	0.23	0.23	0.22	0.22	0.22	0.23	0.22	0.22	0.23	0.23	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.24	0.23
NITROGEN, ORGANIC mg/L	00605	0.15	0.14	0.14	0.14	0.18	0.14	0.15	0.15	0.16	0.15	0.14	0.15	0.17	0.15	0.14	0.18	0.14	0.16	0.18	0.14	0.14	0.14
IRON, TOTAL µg/L	01045	21	43	28	28	28	24	23	27	32	32	18	23	22	19	35	41	31	36	32	39	39	21
PHENOL-LIKE SUBSTANCES µg/L	32730	-	-	5	-	-	< 1	-	-	-	<1	-	<1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
PLATE COUNT 48 hr., 35°C PER mL	31753	14	15	13	5	11	13	6	82	6	4	5	130	1	11	2	55	110	150	190	170	440	42
MF-TC PER 100 mL	31503	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	2	2	6	0	10	4
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	2
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0
PLANKTON PER mL	60050	2500	-	780	1200	1500	630	1300	4800	0	0	900	1600	0	2500	840	960	-	0	-	2800	-	1800
ACTINOS 14 DAY, 25°C PER mL	80148	1	0	1	1	1	1	1	2	1	1	1	2	0	1	1	1	1	1	1	1	1	1
FUNGI PER mL	31856	1	1	1	1	2	0	0	2	2	1	1	2	2	0	1	1	1	2	3	1	1	1

METEOROLOGICAL DATA									PREVAILING WINDS
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SW	SW	SW	SW	SW	SW	SW	SW
VELOCITY	00035	12	10	12	13	10	14	20	

SURVEY BY: K.Rudmin/A.Agrawal

REMARKS: Weather conditions: Sunny W/Some Clouds
Lake Conditions: Waves 1' - 2'

*Denotes IEPA Split Sample Points

Appendix I-21

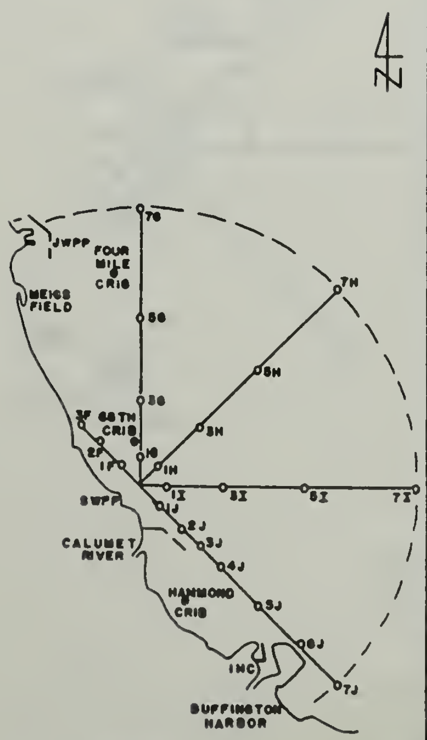
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

S.W.P.P. RADIAL LAKE SURVEY

DATE August 11, 19 87



PARAMETER	STORET NUMBER	1F	2F	3F	1G	3G	5G	7G	1H	3H	5H	7H	1I	3I	5I	7I	1J	2J	3J	4J	5J	6J	7J
		CHW083	CHW079	CHW073	CHW064	CHW074	CHW065	CHW057	CHW065	CHW078	CHW066	CHW058	CHW066	CHW076	CHW067	CHW056	CHW087	CHW082	CHW077	CHW072	CHW068	CHW064	CHW060
TIME		1140	1145	1149	0936	0927	0913	0855	1208	1217	1231	1249	0949	0958	1012	1030	1136	1132	1128	1123	1114	1105	1056
TEMPERATURE °C	00010	24	24	24	23	23	23	23	24	24	24	24	23	23	23	23	24	24	24	24	24	24	24
TURBIDITY F.T.U.	00076	1.0	1.0	1.5	0.95	0.90	0.70	0.80	1.0	0.80	0.65	0.75	1.5	0.75	0.75	0.60	0.70	1.5	0.65	0.80	0.70	0.80	0.75
ODOR, THRESHOLD	00086	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.5	8.5	8.5	8.4	8.5	3.5	8.5	8.4	8.5	8.5	8.5	8.5	8.5	8.4	8.5	8.5	8.5	8.5
SULFATE mg/L	00945	22.9	23.3	24.3	24.5	24.7	24.6	24.8	25.0	24.8	24.9	24.9	24.9	25.3	25.1	24.8	25.6	25.7	26.1	26.0	25.3	22.5	23.4
CHLORIDE mg/L	00940	9.3	9.8	9.1	9.0	9.0	8.9	9.1	9.2	9.0	3.9	8.7	9.8	9.1	9.0	8.8	9.2	9.2	9.3	9.4	8.8	9.0	9.0
PHOSPHATE, TOTAL mg/L	00650	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.07	0.02	0.03	0.01	0.01	0.02	0.01
PHOSPHATE, DISSOLVED mg/L	00653	0.02	0.01	<.01	0.02	<.01	<.01	0.01	0.01	<.01	.01	<.01	0.02	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01
CONDUCTIVITY µ mhos	00095	290	290	285	275	275	275	275	275	275	275	275	275	275	275	275	275	275	270	270	270	270	270
RESIDUE, NONFILTRABLE mg/L	00530	3	5	5	3	3	4	5	5	0	4	6	8	4	2	4	0	5	1	2	3	2	3
OXYGEN DEMAND, CHEMICAL mg/L	00335	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	10.1	5.7	< 5	<5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5.2	7.1
NITROGEN, AMMONIA mg/L	00610	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.23	0.24	0.25	0.24	0.24	0.23	0.23	0.26	0.24	0.24	0.25	0.26	0.25	0.24	0.24	0.26	0.27	0.27	0.26	0.26	0.24	0.23
NITROGEN, ORGANIC mg/L	00605	0.18	0.17	0.17	0.18	0.25	0.17	0.17	0.18	0.17	0.17	0.17	0.17	0.22	0.19	0.22	0.26	0.18	0.22	0.22	0.22	0.18	0.18
IRON, TOTAL µg/L	01045	< 10	< 10	36	26	27	22	33	29	19	< 10	60	55	25	16	19	14	32	22	31	16	14	<10
PHENOL-LIKE SUBSTANCES µg/L	32730	-	-	-	-	-	-	-	-	-	-	-	< 1	< 1	< 1	< 1	<1	<1	< 1	< 1	< 1	<1	<1
PLATE COUNT 48hr., 35°C PER mL	31753	15	26	12	4	5	2	8	8	4	1	2	20	3	3	3	20	110	92	5	5	3	2
MF-TC PER 100 mL	31503	8	6	8	2	2	4	2	2	0	0	0	6	2	2	0	6	2	4	2	0	0	2
MF-FC PER 100 mL	31616	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	4	0	2	0	0	0	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0	0	0	0	0	0
PLANKTON PER mL	60050	210	1200	-	180	60	300	180	90	90	180	1000	660	1500	60	150	150	-	300	-	150	-	150
ACTINOS 14 DAY, 26°C PER mL	80148	1	0	1	0	1	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0
FUNGI PER mL	31856	0	0	0	0	1	2	2	1	1	0	0	0	0	0	0	0	2	2	0	0	0	0

METEOROLOGICAL DATA									PREVAILING WINDS
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	SW	S	S	S	S	SE	SE	S

SURVEY BY: J. Vencill/K.Rudmin

REMARKS: Lake Conditions: 2-4' Waves W/Moderate Lake Swells,
Winds Southerly.

Appendix I-22

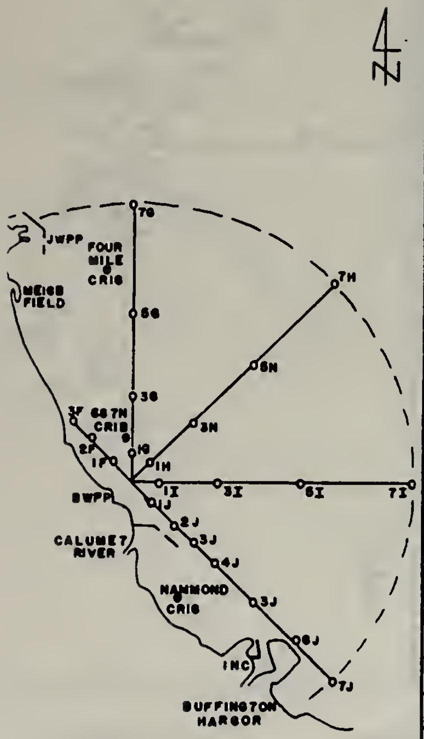
CITY OF CHICAGO
WATER PURIFICATION DIVISION

DEPARTMENT OF WATER
WATER QUALITY SURVEILLANCE SECTION

BUREAU OF WATER OPERATIONS
WATER PURIFICATION LABORATORY

S.W.P.P. RADIAL LAKE SURVEY

DATE September 29, 19 87



PARAMETER	STORET NUMBER	SAMPLING POINT AND STATION NUMBER																					
		1F	2F	3F	1G	3G	6G	7G	1N	3N	6N	7N	1I	3I	6I	7I	1J	2J	3J	4J	5J	6J	7J
		CHW083	CHW078	CHW073	CHW084	CHW074	CHW065	CHW057	CHW085	CHW076	CHW066	CHW058	CHW086	CHW079	CHW067	CHW059	CHW087	CHW082	CHW077	CHW072	CHW068	CNW064	CHW060
TIME		1141	1146	1150	0937	0922	0908	0848	1210	1219	1233	1251	0946	0955	1009	1027	1133	1129	1124	1120	1111	1102	1053
TEMPERATURE °C	00010	20	20	20	19	19	19	19	20	20	20	19	19	19	20	20	20	20	20	20	20	20	20
TURBIDITY F.T.U.	00076	0.75	0.80	0.80	0.70	0.75	0.70	0.80	0.70	0.70	0.70	0.55	0.70	0.75	0.70	0.60	0.75	0.70	0.75	0.75	0.80	0.80	0.70
ODOR, THRESHOLD	00086	1M	1M	1M	20f	20f	2Df	20f	20M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M	1M
pH	00400	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.5	8.4	8.4	8.5	8.5	8.5	8.4	8.5	8.5	8.5	8.5	8.5	8.4	8.4	8.4
SULFATE mg/L	00945	24.2	24.9	25.0	24.9	25.0	24.9	24.7	25.0	24.7	24.8	24.5	24.6	24.7	24.7	24.3	24.9	24.4	24.7	25.3	25.5	25.5	25.4
CHLORIDE mg/L	00940	9.4	9.3	9.3	9.3	9.3	9.0	9.0	9.3	9.0	8.5	8./	9.0	9.5	9.0	8.8	9.2	9.0	8.8	8.9	9.3	9.0	9.3
PHOSPHATE, TOTAL mg/L	00650	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
PHOSPHATE, DISSOLVED mg/L	00653	<.01	0.01	0.01	<.01	0.01	0.01	0.01	0.01	0.01	0.01	<.01	<.01	0.01	<.01	0.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
CONDUCTIVITY µ mhos	00095	290	290	290	285	290	290	285	285	285	275	285	290	285	290	285	290	290	285	290	295	290	290
RESIDUE, NONFILTRABLE mg/L	00530	2	2	0	2	1	0	2	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0
OXYGEN DEMAND, CHEMICAL mg/L	00335	<5	< 5	<5	<5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5.9	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
NITROGEN, AMMONIA mg/L	00610	0.06	0.06	0.02	<.01	0.03	0.02	0.01	<.01	<.01	<.01	0.05	< .01	0.01	< .01	< .01	<.01	<.01	0.02	0.01	<.01	<.01	<.01
NITROGEN, NITRITE-NITRATE mg/L	00630	0.19	0.20	0.20	0.19	0.20	0.20	0.20	0.20	0.19	0.19	0.18	0.19	0.20	0.20	0.19	0.20	0.20	0.20	0.21	0.22	0.22	0.22
NITROGEN, ORGANIC mg/L	00605	0.16	0.16	0.16	0.12	0.12	0.16	0.12	0.12	0.12	0.12	0.16	0.16	0.16	0.16	0.16	0.12	0.12	0.16	0.20	0.12	0.16	0.20
IRON, TOTAL µg/L	01045	< 10	< 10	< 10	16	< 10	< 10	10	16	< 10	< 10	< 10	23	19	13	< 10	17	36	< 10	< 10	< 10	< 10	< 10
PHENOL-LIKE SUBSTANCES µg/L	32730	-	-	-	-	-	-	-	-	-	-	-	3	2	1	1	1	1	2	1	1	1	< 1
PLATE COUNT 48hr., 35°C PER mL	31753	26	45	71	53	63	37	37	23	32	35	0	96	86	160	14	71	94	350	1300	770	320	38
MF-TC PER 100 mL	31503	4	4	2	4	6	0	8	2	2	0	0	6	2	2	0	4	6	4	0	8	8	6
MF-FC PER 100 mL	31616	2	0	2	0	2	0	2	0	0	0	0	4	0	0	0	2	6	2	0	0	4	0
MF-FS PER 100 mL	31679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0	0	0	0	0	0
PLANKTON PER mL	60050	390	-	540	120	780	240	210	1200	90	3100	150	180	150	1400	150	5500	-	2700	-	1100	-	1200
ACTINOS 14 DAY, 20°C PER mL	80148	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	2	1
FUNGI PER mL	31856	2	1	2	2	2	1	1	3	2	0	1	1	4	0	2	1	0	0	2	1	2	2

METEOROLOGICAL DATA									PREVAILING WINDS
TIME		0800	0900	1000	1100	1200	1300	1400	00036
DIRECTION	00036	NW	NW	NW	NW	NW	NW	NW	NW
VELOCITY	00035	13	10	11	12	12	11	11	

SURVEY BY: J.Vencill/R.Rak

REMARKS: Weather conditions: Partly Cloudy Mild Temperatures.
Lake Conditions: Brisk winds Waves 4' and increasing, moderate to large lake swells.

APPENDIX II

METALS AND CYANIDE DATA

Appendix II-1. Concentrations of total metals, cyanide, fluoride and hardness at six Lake Michigan JWPP stations sampled on May 13, 1987.

Parameters	Standard	5A	5B	1C	5C	5D	4E
Cyanide (mg/L)	0.025(a)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride (mg/L)	1.40(c)	-	-	-	-	-	-
Calcium (mg/L)	-	36	35	37	37	37	37
Magnesium (mg/L)	-	13	11	14	14	14	14
Hardness * (mg/L)	-	141	135	147	149	150	150
Potassium (mg/L)	-	0.54	0.3	0.79	0.90	0.92	0.99
Sodium (mg/L)	-	4.9	4.9	5.3	5.3	5.3	5.2
Aluminum (ug/L)	-	<50	<50	57	<50	<50	<50
Arsenic (ug/L)	50(b)	3	<1	<1	<1	<1	<1
Barium (ug/L)	1000(b)	18	22	22	20	19	18
Beryllium (ug/L)	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50
Cadmium (ug/L)	10(b)	<3	<3	<3	<3	<3	<3
Chromium (ug/L)	50(b)	8	<5	<5	<5	<5	7
Cobalt (ug/L)	-	<5	<5	<5	<5	<5	<5
Copper (ug/L)	20(c)	6	<5	<5	<5	<5	<5
Iron (ug/L)	1000(c)	<50	<50	<50	<50	<50	53
Lead (ug/L)	50(b)	<50	<50	<50	<50	<50	<50
Manganese (ug/L)	150(b)	<5	<5	<5	<5	<5	<5
Mercury (ug/L)	0.5(c)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel (ug/L)	1000(c)	7	<5	<5	<5	<5	7
Silver (ug/L)	5(c)	4	<3	<3	<3	<3	<3
Strontium (ug/L)	-	117	116	120	120	121	120
Vanadium (ug/L)	-	<5	<5	<5	<5	<5	<5
Zinc (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50

a) Lake Michigan Standard (35 IL Adm. Code 302)
b) Public and Food Processing Water Supply Standard (35 IL Adm. Code 302)
c) General Use Standard (35 IL Adm. Code 302)
* Calculated

Appendix II-2. Concentrations of total metals, cyanide, fluoride and hardness at six Lake Michigan SWPP stations sampled on May 27, 1987.

Parameters	Standard	3F	5G	5H	5I	2J	5J
Cyanide (mg/L)	0.025(a)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride (mg/L)	1.40(c)	-	-	-	-	-	-
Calcium (mg/L)	-	37	37	37	36	35	37
Magnesium (mg/L)	-	15	15	14	13	12	15
Hardness * (mg/L)	-	153	153	151	143	137	152
Potassium (mg/L)	-	1.4	1.4	0.95	0.3	0.3	1.2
Sodium (mg/L)	-	5.1	5.2	5.1	5.1	5.3	5.8
Aluminum (ug/L)	-	<50	<50	<50	<50	<50	<50
Arsenic (ug/L)	50(b)	<1	<1	<1	<1	<1	<1
Barium (ug/L)	1000(b)	14	14	14	18	21	16
Beryllium (ug/L)	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50
Cadmium (ug/L)	10(b)	<3	<3	<3	<3	<3	<3
Chromium (ug/L)	50(b)	26	17	16	<5	<5	18
Cobalt (ug/L)	-	6	5	<5	<5	<5	<5
Copper (ug/L)	20(c)	<5	5	<5	<5	<5	<5
Iron (ug/L)	1000(c)	109	107	<50	<50	<50	112
Lead (ug/L)	50(b)	<50	<50	<50	<50	<50	<50
Manganese (ug/L)	150(b)	10	10	5	<5	<5	13
Mercury (ug/L)	0.5(c)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel (ug/L)	1000(c)	17	16	<5	<5	<5	<5
Silver (ug/L)	5(c)	8	<3	3	<3	<3	<3
Strontium (ug/L)	-	115	115	115	113	112	116
Vanadium (ug/L)	-	<5	<5	<5	<5	<5	<5
Zinc (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50

a) Lake Michigan Standard (35 IL Adm. Code 302)
b) Public and Food Processing Water Supply Standard (35 IL Adm. Code 302)
c) General Use Standard (35 IL Adm. Code 302)
* Calculated

Appendix II-3. Concentrations of total metals, cyanide, fluoride and hardness at six Lake Michigan SWPP stations sampled on September 29, 1987.

Parameters	Standard	3F	5G	5H	5I	2J	5J
Cyanide (mg/L)	0.025(a)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride (mg/L)	1.40(c)	0.14	0.16	0.15	0.17	0.16	0.18
Calcium (mg/L)	-	38	37	35	36	36	36
Magnesium (mg/L)	-	12	11	11	11	11	11
Hardness * (mg/L)	-	143	138	130	136	133	133
Potassium (mg/L)	-	1.2	1.1	1.0	1.1	1.1	1.1
Sodium (mg/L)	-	6.0	5.6	5.3	5.7	5.4	5.7
Aluminum (ug/L)	-	<50	<50	<50	<50	<50	<50
Arsenic (ug/L)	50(b)	<1	<1	<1	<1	<1	<1
Barium (ug/L)	1000(b)	23	22	21	22	21	21
Beryllium (ug/L)	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50
Cadmium (ug/L)	10(b)	<3	<3	<3	<3	<3	<3
Chromium (ug/L)	50(b)	<5	<5	<5	7	<5	<5
Cobalt (ug/L)	-	<5	<5	<5	<5	<5	<5
Copper (ug/L)	20(c)	<5	<5	<5	5	<5	<5
Iron (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50
Lead (ug/L)	50(b)	<50	<50	<50	<50	<50	<50
Manganese (ug/L)	150(b)	<5	<5	<5	<5	<5	<5
Mercury (ug/L)	0.5(c)	<0.05	<0.05	-	<0.05	<0.05	<0.05
Nickel (ug/L)	1000(c)	<5	<5	<5	6	6	5
Silver (ug/L)	5(c)	<3	<3	<3	4	<3	<3
Strontium (ug/L)	-	122	121	113	117	115	115
Vanadium (ug/L)	-	<5	<5	<5	<5	<5	<5
Zinc (ug/L)	1000(c)	<50	<50	<50	<50	<50	<50

a) Lake Michigan Standard (35 IL Adm. Code 302)
b) Public and Food Processing Water Supply Standard (35 IL Adm. Code 302)
c) General Use Standard (35 IL Adm. Code 302)
* Calculated

APPENDIX III

GLOSSARY

Actinomycetes

A group of organisms related to both fungi and bacteria with the capacity to produce quantities of odoriferous substances. Identification of their relative abundance in a drinking water source provides a parameter in the assessment of water quality. Organic substances such as phenol, cellulose and dead plant cells will provide sufficient carbon and nitrogen to stimulate actinomycetes population growth.

*Aldrin

Aldrin is an organochlorine compound primarily used as an insecticide. A fumigant, contact, and stomach pesticide, aldrin is most dangerous when absorbed through the skin. Aldrin is no longer manufactured in the United States. The standard for aldrin in public water supply waters is 1.0 ug/L (35 IL Adm. Code 302).

Barium

Barium is an alkaline earth metal which occurs in nature chiefly as the insoluble salts barite and witherite. Many of the barium salts are soluble in water, but they are thought to be rapidly precipitated or removed from solution by absorption and sedimentation. Barium compounds are used in the manufacture of paints, glass, paper, explosives, lubricating oils, and synthetic rubber, as well as for printing and dyeing fabrics and for medicinal purposes. Barium concentrations in surface waters can be as high as 340 ug/L (McNeely et al., 1979). Concentrations greater than 5000 ug/L are harmful to many fish species (McNeely, et al., 1979). The public and food processing water supply standard for Barium is 1.0 mg/L (35 IL Adm. Code 302).

* On the USEPA list of Section 307 priority pollutants.

*Beryllium

Beryllium is a relatively rare element that does not usually occur in natural waters. Although beryllium chloride and nitrate are highly soluble in water, and beryllium sulfate is moderately soluble, beryllium carbonate and hydroxide are almost insoluble in cold water of alkaline pH. Beryllium is used primarily in metallurgy to produce special alloys, in the manufacture of X-ray diffraction tubes and electrodes for neon signs, and in nuclear reactors. Beryllium is usually present in concentrations less than 1.0 ug/L (McNeely et al., 1979). The USEPA (1976) recommended a standard of 11 ug/L beryllium for the protection of aquatic life in soft freshwater and 1,100 ug/L in hard freshwater.

Boron

Boron is never found in nature in its elemental form; it is usually found as a sodium or calcium borate salt. Elemental boron can be used in nuclear reactors as a neutron absorber. Boric acids and boron salts are used for weatherproofing wood, fireproofing fabrics, the manufacture of glass, porcelain, leather, carpets, cosmetics, photographic materials and other purposes. Boric acid is also used as a fungicide, a bactericide, and as a component in several pesticides. The average concentration of boron in surface waters is usually near 100 ug/L. However, concentrations up to 4000 ug/L have been found in the winter when groundwater, which may contain greater amounts, constitutes a larger portion of the total discharge (McNeely et al., 1979).

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*On the USEPA list of Section 307 priority pollutants.

*Cadmium

Cadmium is relatively rare in water and occurs in nature chiefly as a sulfide salt most frequently found in association with zinc and lead. Anthropogenic inputs can be significant. Cadmium salts occur in wastes from manufacture of pigments, electroplating plants, and chemical and textile industries. The combustion of fossil fuels releases cadmium to the atmosphere which eventually enters the hydrologic cycle through precipitation. Cadmium can accumulate in soils in the area of mines and smelters resulting in locally high concentrations in water. Cadmium is a non-essential biological element which is cumulative and highly toxic to most organisms including man. Increased hardness and/or alkalinity have been shown to decrease cadmium toxicity (USEPA, 1976; McNeely et al., 1979). As a result of the cumulative toxic effect of cadmium, the Illinois Pollution Control Board has stipulated the waters of the State shall not exceed a concentration of 50 ug/L and water used for food processing and public consumption shall not exceed a concentration of 10 ug/L (35 IL Adm. Code 302).

*Chlordane

Chlordane is an organochlorine compound primarily used as an termiticide. It is both a stomach and contact insecticide. The standard for chlordane in public water supplies is 3.0 ug/L (35 IL Adm. Code 302).

Chloride

Chloride (Cl^-) is the only commonly occurring aqueous constituent in fresh water systems that can be considered conservative. Conservative constituents do not combine with other aqueous or solid phases and are not

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* On the USEPA list of Section 307 priority pollutants.

removed from the system by chemical precipitation, absorption or adsorption on mineral surfaces, metabolic processes, or chelating. Consequently, chloride is used as an index of chemical loading and buildup of pollutants (Tiffany and Winchester, 1969; Tiffany et al, 1969). Chloride originates from many sources, including salt from highway and street de-icing, chloride compounds used by industry, additives to cleaning compounds, atmospheric aerosols and natural weathering of minerals (Ownbey and Kee, 1967). The standard for chloride in Lake Michigan is 12.0 mg/L (35 IL Adm. Code 302).

Chlorophyll

Chlorophyll a is the major photosynthetic pigment contained in plants. Extraction and quantification of this pigment can be used to estimate the amount (biomass, standing crop) of planktonic algae present in a body of water. Lakes with chlorophyll a concentrations less than 4 ug/L are classified as oligotrophic (relatively unproductive), those with values between 4 and 10 ug/L as mesotrophic (moderately productive) and those with concentrations greater than 10 ug/L as eutrophic (very productive).

*Chromium

Chromium is an amphoteric metal whose most common oxidation states are +2, +3, and +6. The trivalent and hexavalent forms are of major environmental concern. Because of its low solubility, the trivalent form is rarely found in waters with a pH greater than 5, and when added to most natural waters, is slowly oxidized to the hexavalent form (McNeely et al., 1979). Chromium has many industrial uses. The hexavalent form is used in

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* On the USEPA list of Section 307 priority pollutants.

metal plating, anodizing of aluminum, and in the manufacture of stainless steel, ceramics, paper, and paint. Trivalent chromium is used in photography, in textile dyeing, and in ceramic and glass industries. Chromium is also added to cooling tower waters to inhibit corrosion.

Trivalent chromium is an essential metal for mammals. Deficiencies reduce insulin activation and are known to cause glucose intolerance inhumans (USEPA, 1976). Hexavalent chromium is toxic to humans. It is irritating and corrosive to the mucus membranes and is a known carcinogen. Both the trivalent and hexavalent ions are toxic to plants. The toxicity of chromium to aquatic life varies from species to species and is dependent on oxidation state, pH, and temperature (McNeely et al., 1979). The public and food processing water supply standard for chromium is 50 ug/L (35 IL Adm. Code 302).

Cobalt

Cobalt is a heavy metal which may be present in the relatively stable bivalent form, and in the unstable trivalent form. Cobalt is used for making alloys, in nuclear technology, as pigments in the china and glass industry, and in animal feed supplements. As a result, municipal and industrial effluents may contribute cobalt to surface waters. The burning of coal and oil releases cobalt to the atmosphere, which returns to the earth's surface during precipitation events. Natural surface waters usually contains less than 0.1 ug/L cobalt (McNeely et al., 1979). Cobalt concentrations of 1000 ug/L were not found to be harmful to one-year-old tench, carp, rainbow trout and char, nor to crustacea, worms, or insect larvae, although higher concentrations have shown pronounced toxic effects (McKee and Wolf, 1971).

Coliform, Total

Total coliform bacteria are associated with feces of warm-blooded animals as well as in soils and on plants. These bacteria are characterized by gram-negative asporogenous rods.

Coliform, Fecal

Bacteria that comprise a portion of the total coliform group. Fecal coliform are of more sanitary significance than total coliform because they are restricted to the intestinal tract of warm-blooded animals. Consequently, this group serves as an indicator of possible recent sewage contamination. Based on a minimum of five samples collected over not more than a 30 day period, the fecal coliform geometric mean shall not exceed 20/100 mL (35 IL Adm Code 302).

Conductivity

The measure of the ability of a substance to conduct an electric current. The measurement provides an indication of ion concentrations or dissolved solids in water.

*Copper

Although generally present in only trace amounts, copper is a common heavy metal constituent of most natural waters. High concentration of copper may occur in water drainage from mines and some industrial effluents. Copper has been mined and used extensively since prehistoric times. It is used in electrical products, coins, electroplating, and in industrial processes such as gas works, coke ovens and gas scrubbing steel plants. It is often alloyed with other metals to form bronzes and brasses.

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Copper is an essential micronutrient for plants and animals. In plants it plays a vital role in chlorophyll synthesis and is a constituent of several enzymes. In animals, copper is important in invertebrate blood chemistry as hemocyanin and in hemoglobin synthesis. Like most metallic micronutrients, relatively high concentrations are toxic. Toxicity varies with oxidation state and a number of physiochemical parameters such as temperature, hardness, alkalinity and turbidity. The total copper standard for general use waters is 0.02 mg/L (35 IL Adm. Code 302).

*Cyanide

Cyanide is one of the simplest and most readily formed organic compounds. Besides being very important in a number of manufacturing processes, cyanide and compounds of cyanide are found in many plants and animals as metabolic intermediates which generally are not stored for long periods of time. Cyanide sources to Lake Michigan have been associated with waste effluents from gas works and coke ovens, gas scrubbing at steel plants, metal cleaning and electroplating processes, and chemical industries. Cyanides are seldom detected in Lake Michigan except in polluted harbors or near the vicinity of harbor mouths (Torrey, 1976). Toxicity varies with pH, temperature and dissolved oxygen. The Lake Michigan standard for cyanide is 0.025 mg/L (35 IL Adm. Code 302).

*Dichloro diphenyl trichloroethane (DDT)

DDT is an aromatic insecticide which accumulates in the fatty tissues of warm-blooded animals. In the past, DDT was widely used to control agricultural pests, many of which were found to have hereditary resistance to the compound. Use of DDT in the United States was prohibited effective

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January 1, 1973. It is still detected in lakes and streams; the Illinois Pollution Control Board has designated the maximum allowable concentration in public water supply waters to be 50.0 ug/L.

*Dieldrin

Dieldrin is an organochlorine compound primarily used as an insecticide. It is an isomer of endrin. The use of dieldrin has been banned and its manufacture has been discontinued in the United States; however, due to its resistance to decomposition, it is still detected in some lakes and streams. The standard for dieldrin in public water supply waters is 1.0 ug/L (35 IL Adm. Code 302).

*Endrin

Endrin is an organochlorine compound primarily used an insecticide. The standard for endrin in public water supply waters is 0.2 ug/L (35 IL Adm. Code 302).

Fungi

Fungi are plants which lack chlorophyll and are able to grow in the absence of light. Favorable growth followed by a large die-off results in disagreeable tastes and odors.

Hardness

Hardness is principally determined by the sum of calcium and magnesium. Water hardness relates to a waters capacity to produce lather from soap. The harder the water, the more difficult it is to lather soap. Hardness ranges from 0-30 mg/L $CaCO_3$ for very soft water and is greater than 180 mg/L $CaCO_3$ for very hard water.

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***Hexachlorobenzene** (HCB)

HCB is an organochlorine compound used as a fungicide for seeds and as a wood preservative. The USEPA currently recommends an upper limit of 0.5 ppm in fatty tissues of cattle, pigs and sheep; however, this limit is subject to change after further toxicological research. Previous work on laboratory animals indicated a low level of toxicity.

***Hexachlorocychlohexane** (BHC)

BHC is an organochlorine compound. The gamma isomer is lindane. It is highly toxic by ingestion, and moderately by inhalation. It can be absorbed through the skin and is a strong irritant to skin and eyes. BHC formerly had extensive use for control of cotton insects. It is no longer produced in the United States and sale for domestic use is prohibited by the USEPA.

Iron

Iron is an abundant element common in many rocks and soils and may be present in water in varying quantities, dependent upon the geology of the area and other chemical components of the waterway. Sources of excess iron include industrial wastes, mine drainage waters, and iron-bearing groundwaters. Iron is an essential micronutrient, and under certain conditions can limit photosynthetic productivity. Iron is considered an objectionable constituent in water supplies, and can affect the taste of beverages and stain laundry. The general use standard for iron is 1000 ug/L (35 IL Adm. Code 302).

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*Lead

Due to its low solubility, lead concentrations in water are generally not great. Lead enters the aquatic environment through natural sources, chiefly by the weathering of its sulfide ores. Input from anthropogenic sources clearly exceeds natural sources. Major inputs result from burning of leaded fuel, ore smelting and refining, storage battery production, and municipal waste discharges. Lead salts are used in printing and dyeing, photography, engraving, and the manufacture of explosives (McNeely et al., 1979).

Lead is not an essential biological element. It is toxic and accumulates in animal tissues. The degree of toxicity, as with other trace metals, is dependent on numerous water quality parameters such as hardness, alkalinity, pH, and others. The toxic effects of lead concentrations on aquatic organisms is highly variable and species dependent (USEPA, 1976). In humans the extent and effect of lead toxicity is age dependent, with young children particularly susceptible to neurological impairment. Accordingly, the Illinois Pollution Control Board has limited maximum allowable concentrations of total lead to 0.1 mg/L in general use waters and 0.05 mg/L in public and food processing water supplies (35 IL Adm. Code 302).

*Lindane

Lindane is the gamma isomer of 1, 2, 3, 4, 5, 6 hexachlorocyclohexane (BHC); the addition product of benzene and chlorine reacting in direct sunlight. This insecticide is a central nervous system stimulant for which there is no specific antidote. The Illinois Pollution Control Board has set 4.0 ug/L as the maximum lindane concentration for public and food processing water supply waters (35 IL Adm. Code 302).

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Manganese

Soils and sediments are important sources of manganese along with metamorphic and sedimentary rocks. Manganese is not usually present in appreciable concentrations in surface waters. It seldom reaches concentrations of 1.0 mg/L in natural surface waters and is usually present at levels of 0.2 mg/L or less (McNeely et al., 1979). Industrial wastes and acid-mine drainage may contribute manganese to waters. Manganese is an essential micronutrient, and under certain conditions can limit photosynthetic productivity. Manganese is considered an objectionable constituent in water supplies, and can affect the taste of beverages and stain laundry. The maximum allowable manganese concentration in public and food processing water supplies is 150 ug/L (35 IL Adm. Code 302).

Magnesium

Magnesium is an alkaline-earth metal which is abundant in natural waters. Magnesium and calcium are the two main components responsible for water hardness. Ferromagnesian minerals in igneous rocks and dolomite sedimentary rocks are the principal contributors of magnesium to water. Industrial waste waters can also be a source of magnesium.

*Mercury

Mercury, the only liquid metal at ordinary temperatures, is a biologically non-essential trace metal. The majority of U.S. waters contain less than 0.1 ug/L total mercury (USEPA, 1976). Historically, because of its toxic effects, mercury was used as a pesticide; however, its use in recent years has been restricted., The major anthropongenic inputs now result from various commercial and industrial processes such as manufacture of paints, mercury switches, dental work, and chlorine gas production.

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Mercury compounds are highly toxic to animals, particularly the methylated forms which can be produced by microorganisms from the less toxic inorganic forms. Aquatic organisms are capable of removing mercury directly from water as well as from food. Due to its low elimination rate, mercury is concentrated in body tissues. Concentration factors in fish can be more than 10,000 times aquatic concentrations (USEPA, 1976). Due to its high toxic potential and possible biomagnification in aquatic food webs, the Illinois Pollution Control Board has determined that acceptable levels of total mercury in Illinois waters should not exceed 0.5 ug/L (35 IL Adm. Code 302).

Methoxychlor

Methoxychlor is an organochlorine insecticide. It has a long residual action on many species, but is not highly toxic to warm-blooded animals. The maximum allowable methoxychlor concentration for public supply waters is 100.0 ug/L (35 IL Adm. Code 302).

*Nickel

Nickel is a silver-white, metallic element seldom occurring in nature in the elemental form. Nickel salts are soluble and can occur as a leachate from nickel bearing ores. Human activities which may contribute nickel to the environment include the burning of fossil fuels, metal plating and processing of nickel ores. The median freshwater concentration of nickel in North American rivers is 100 ug/L, although concentrations are often undectectable (McNeely et al., 1979). The Illinois Pollution Control Board has set 1000 ug/L as the maximum allowable nickel concentration in general use waters (35 IL Adm. Code 302).

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Nitrogen, Ammonia

Ammonia nitrogen results from the anaerobic decomposition of nitrogenous organic matter. It may be present in surface waters as a result of agricultural runoff, certain industrial wastes, and runoff from pastures of feedlots. It is a component of sewage treatment facilities. The importance of ammonia in freshwater is associated with its toxicity to fishes (this toxicity varies with water temperature and pH) and its potential for coversion to nitrogen forms readily assimilated by aquatic plants. The maximum allowable ammonia nitrogen concentration in Lake Michigan is 0.02 mg/L (35 IL Adm. Code 302).

Nitrogen, Nitrite-Nitrate

Nitrate-nitrogen is commonly found in surface waters as a result of the aerobic decomposition of organic nitrogen in polluted streams and from sewage effluents, agricultural runoff, cesspool leaching, and industrial discharges. Nitrites in natural waters result from bacterial oxidation of ammonia and organic nitrogen. Because they are readily oxidized to nitrates, nitrites are not normally found in significant concentrations. In addition to serving as plant nutrients, nitrate-nitrite is also a major public health consideration because high concentrations may cause infant methemoglobinemia (blue baby syndrome).

Nitrogen, Organic

Organic nitrogen is defined functionally as organically bound nitrogen. Organic nitrogen includes such natural materials as proteins and peptides, nucleic acids and urea, and numerous synthetic organic materials.

*Nonachlor

Nonachlor is an organochlorine compound which is a product of technical chlordane. It is used as an insecticide.

Odor, Threshold

Odor is recognized as a quality factor affecting water in several ways: acceptability of drinking water, tainting of fish and other aquatic organisms, and aesthetics of recreational waters. Odor tests are performed to arrive at qualitative descriptions and approximate quantitative measurements of odor intensity. The method for intensity measurement is the threshold odor test.

Oxygen Demand, Chemical

A measure of the oxygen-comsuming capacity of inorganic and organic matter present in water or wastewater.

*Pentachlorophenol

Pentachlorophenol (PCP) is a chlorinated hydrocarbon that is prepared commercially by the chlorination of phenol in the presence of a catalyst. It is used primarily as a wood preservative, herbicide, insecticide, molluscicide, bactericide, fungicide and slimicide. PCP is slightly soluble in water; it's sodium phenate salt is highly soluble in water. PCP decomposes into several products including lower chlorophenol isomers, anisoles, dibenzofurans and dioxins. It can also be a degradation product of hexachlorobenzene (HCB) and lindane.

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pH

pH is a logarithm of the reciprocal of the hydrogen ion concentration. pH measures the balance between the acids and bases in water by the concentration of hydrogen ions. By definition, the pH range is from 0 (most acidic) to 14 (most alkaline). Since the concentration of hydrogen ions regulates the degree of dissociation of many substances, pH may be a significant factor in determining limiting threshold concentrations in natural waters. The pH of Lake Michigan shall be within the range of 7.0 to 9.0 except for natural causes (35 IL Adm. Code 302).

*Phenols

Phenols are associated with industrial wastes from coal distillation processes and the manufacture of plastics, dyes, and disinfectants. Relatively small concentrations can cause taste and odor problems in public water supplies. The public and food processing water supply standard for phenols is 1.0 ug/L (35 IL Adm. Code 302).

Pheophytin

A brown pigment, produced by the degradation of chlorophyll.

Phosphate, Total

Phosphate is found in domestic sewage, some industrial wastes, and drainage from agricultural areas. It is one of the nutrients responsible for excessive algae growth. The Lake Michigan total phosphate water quality standard is 0.021 mg/L (or 0.007 mg/L as P) (35 IL Adm. Code 302).

Phosphate, Dissolved (Total Filterable)

The phosphate forms that pass through a 0.45 um membrane.

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Plankton

Minute animals (zooplankton) and plants (phytoplankton) that are suspended in a body of water and, because of their physical character or size, are incapable of sustained mobility in directions counter to water currents.

Plate Count

Number of colonies of bacteria grown on selected solid media at a given temperature and incubation period. The procedure provides a standardized means of determining the density of bacteria in water.

*Polychlorinated biphenyls (PCB's)

PCB's are not pesticides per se, however, the "kill life" of chlorinated hydrocarbon insecticides is extended via the synergistic effects of PCB's. PCB's are resistant to degradation by ordinary physical and chemical means; they will only decompose if heated to 950°C. As a result, even banning the use and manufacture of PCB's in the United States is not completely effective in removing PCB's from the environment. They are insoluble in water and accumulate in the lipids of living systems. Concentrated in the food web, PCB's can cause human disorders ranging from fatigue to bone deformities.

Potassium

Naturally occurring element that is an essential plant nutrient. High concentrations in water may be a result of discharge, groundwater or sedimentary runoff.

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Residue, Filterable

The dissolved mineral constituents of water that will pass through a 0.45 um filter and remain after evaporation. Also called total dissolved solids.

Residue, Nonfilterable

The portion of the total residue retained by a 0.45 um filter.

Secchi Disc Transparency

Secchi disc transparency is a measure of the clarity or transparency of the water. It is the depth to which a weighted metal plate with alternating black and white quadrants lowered into the water by a calibrated rope is visible. Measurements taken with a secchi disc indicate the light penetration into a body of water. Algae, zooplankton, water color and sediment are factors which interfere with light penetration and lessen the secchi transparency.

Silica, (SiO_2)

Silica is a nutrient essential to diatoms, which incorporate it into their cell walls. Increases in diatom populations cause a reduction in silica concentrations.

*Silver

Silver is found in its elemental state as well as in combination with several ores. Significant levels of silver in natural waters are low because of the insolubility of silver salts such as chloride, sulfide,

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phosphate and arsenate. Freshwater concentrations of silver range from 0.2 ug/L to 39 ug/L (McNeely et al., 1979). Silver metal is used in jewelry and silverware, in alloys for electroplating and the processing of food and beverages. Silver nitrate is used in photography, ink manufacturing, electroplating, coloring porcelain, and as an antiseptic (McKee and Wolf, 1971). The general use standard for silver is 5.0 ug/L (35 IL Adm. Code 302).

Sodium

Naturally occurring element in surface waters. Relatively high concentrations may be found in brines and hard waters.

Streptococci, Fecal

The fecal streptococcal group of bacteria is closely associated with sewage discharges. This group serves as a supplementary indicator of recent sewage contamination.

Strontium

Strontium is an alkaline-earth metal that is chemically similar to calcium. It is not found free in nature, but occurs chiefly with calcium or barium minerals, in the form of sulfate or carbonate. Strontium salts are only slightly soluble in water. The weathering of sedimentary rocks are the principal sources of strontium to the aquatic environment. There are no significant industrial sources of strontium, however, nuclear bomb tests resulted in radioactive strontium-90 fallout. Most natural surface water contains only a few milligrams per liter (McNeely et al., 1979).

Sulfate

Many organic and inorganic sulfur compounds in a lake system can exist in either an oxidized or reduced form. In an oxidizing environment most of the sulfur compounds occur as sulfate ions (SO_4^{-2}). For this report our anaysis is the measure of inorganic compounds containing sulfate ions. Sulfate is a component of natural bodies of water. Abnormal fluctuations in background levels may be the result of municipal and industrial discharges, land runoff and atmospheric deposition (Ownbey and Willkek, 1965; Junge, 1960). The maximum allowable sulfate concentration in Lake Michigan is 24.0 mg/L (35 IL Adm. Code 302).

Turbidity

Turbidity is a measure of the suspended particles such as silt, clay, organic matter, plankton, and microscopic organisms in water which are usually held in suspension by turbulent flow and Brownian movement. Turbidity is measured by comparing the optical interferences of suspended particles to the transmission of light in an instrument previously standardized with samples of standard turbidity units.

Vanadium

Metallic vanadium does not occur free in nature, but minerals containing vanadium are widespread. Vanadium has several valence states. The trivalent salts are insoluble but the tetravalent and pentavalent salts are soluble in water. The pentavalent salts have the greater toxicity. Vanadium metal is used in metallurgy to increase the hardness and malleability of steel, and the salts are used in the manufacture of glass, in photography and as a mordant in dyeing and printing fabrics. It is also used in automobile catalytic converters to reduce hydrocarbon emissions. The burning of fossil fuels also releases vanadium to the environment.

*Zinc

Zinc is a biologically essential trace metal, and a necessary component of certain plant and animal enzymes. It is generally found in nature as a sulfide associated with other metals such as lead, copper, cadium, and iron. Industrially, zinc is important in galvanizing, in the preparation of alloys for die casting, in brass and bronze alloys, and in certain chemical products such as paint, fertilizers and pesticides.

Zinc is relatively non-toxic to man, with public drinking water concentrations limited on an aesthetic basis. Zinc, however is acutely and chronically toxic to aquatic organisms, especially fish (McNeely et al., 1979). The degree of toxicity is determined by a number of parameters including pH, DO, hardness, temperature, and alkalinity. The maximum allowable zinc concentration in general use waters is 1.0 mg/L (35 IL Adm. Code 302).

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The Great Lakes system is usually considered to be the largest (95,000 square miles) source of fresh surface water in the world, with the exception of the polar ice caps. Lake Michigan is the third largest of all the Great Lakes in area and it is the largest body of fresh water entirely within the boundaries of the United States.

As a natural resource of immeasurable value, Lake Michigan serves a broad spectrum of purposes. It provides drinking water for an estimated five million residents in the northeastern Illinois area. Its recreational opportunities attract fishing, boating, swimming and other water-oriented interests. The lake also serves as an avenue for domistic and international water-borne commerce. Industry and commerce have grown and developed giving the greater Chicago metorpolitan area one of the largest industrial-commercial complexes in the United States. Consequently, some of Lake Michigan's water quality problems result from discharges of industrial and municipal wastes.

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